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Baffle Piers at Toe of Dam Dispel Energy of Flow

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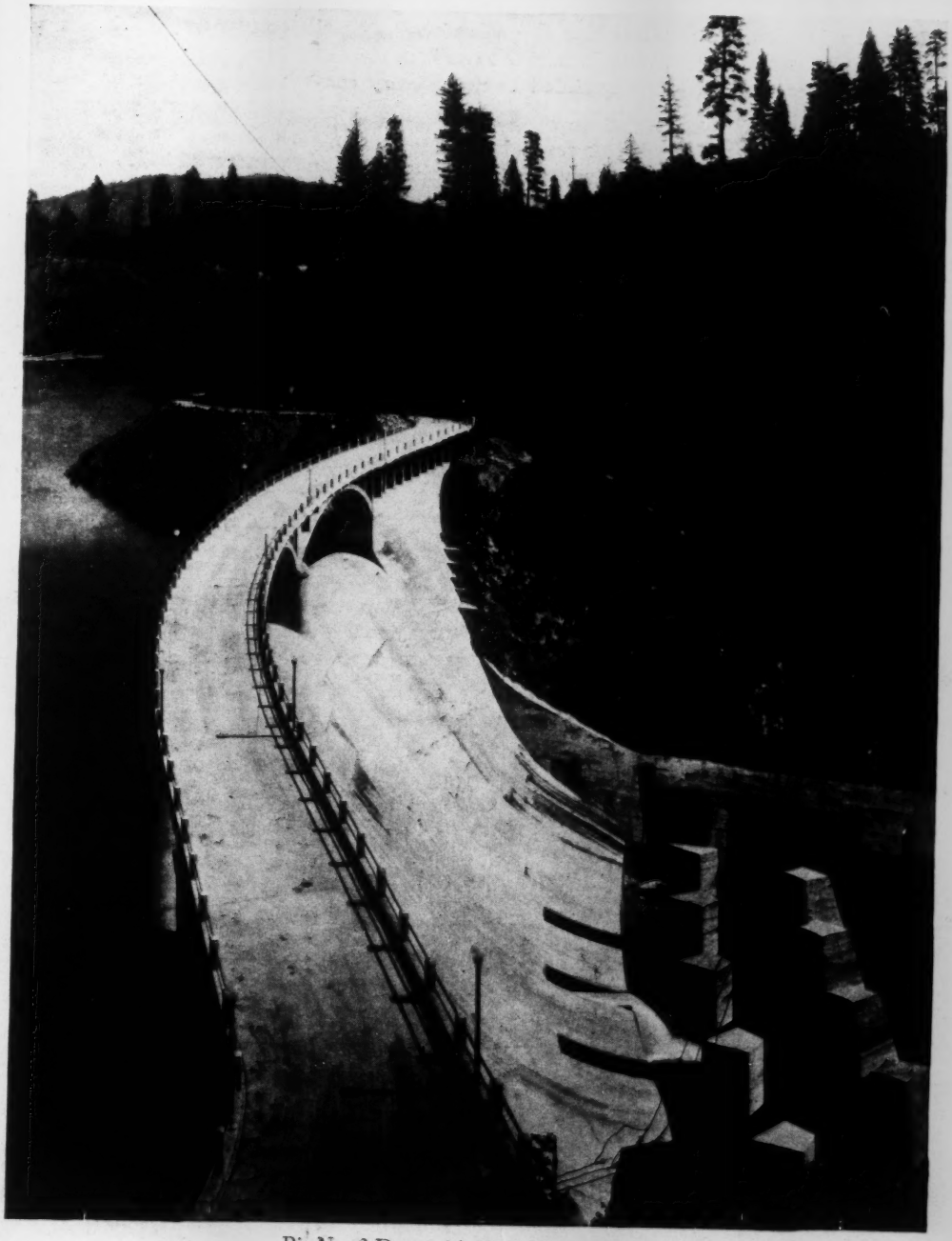

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FRANK C. WIGHT
Editor

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The New Crop of Engineers

WITHIN the next few weeks about 9,000 young men will go forth from our colleges with some sort of an engineering degree. That is a rather formidable army, but it will disappear with little commotion into the much greater ranks of the practicing engineers and of industry. Censuses of engineers do not exist so no one can tell just how many engineers there are or even how great is the demand for new ones. But this year seems not to differ from any of those of late in that the new graduates find little trouble in placing themselves to their own satisfaction, which means of course that employers, whether in what is generally supposed to be engineering or not, are beginning to appreciate that engineering education, criticized though it may be, is producing something that they need and want. At this time then, when rejuvenation of the engineering profession and industry is in progress, it is timely to repeat a warning to both prospective employer and employee. To the employer —do not fall into the easy assumption that the new graduate thinks he knows it all. To the employee — remember that you have been learning not so much how things are done as how to do things. If this tolerance from the elder is met with a proper subjectiveness by the younger, mutual appreciation will soon develop and the real purpose of engineering education will have been achieved.

Why an Exposition Anyhow

PUNCTUALITY seems to be a congenital virtue. Some people just cannot be on time. That kind of foresight which insures early preparation for a coming event is denied them or at least is not sought or cultivated. To this group belong those who promote those mammoth expositions that our cities love to stage to their own greater glory and to the profit of their business men. Philadelphia today is no exception to the rule. Fifty years ago she put on in the Centennial of the Declaration of Independence one of the classic shows of the century. With the same notable benchmark to measure from she now draws to herself further notice by setting up another exposition on the Delaware River flats, where realty profits may be most discreetly taken. But in spite of the fact that she has been talking about this celebration for a decade and actively planning it for half that time, Philadelphia theoretically opens this week an exposition which is merely the skeleton of a show, some buildings under way and some earthfills being made, a stadium and a few roads. By July 4, the real sesquicentennial, a little more will be done by dint of war-time construction activity—and war-time construction cost—and maybe by next fall there will be an exposition. Why the delay, unless even those who are booming the show know that the day of the great exposition passed with the Chicago Fair. We are no longer a provincial people, astonished by the wonders of invention and shocked by the vagaries of art. The world closes in upon all of us, and the farm and the village house as informed and as traveled minds as the apartment and the city block. We don't need to be educated as we did in 1876 or even in 1893 as to what the world is doing. Expositions are today only a species of self glorification for cities—when they are not something worse.

Roads in Porto Rico

PORTO RICAN highway development under the guidance of U. S. Army engineers has followed remarkably sane lines, as the article in this issue by an engineer who knows his native America makes exceptionally plain. Nearly all of the island's highway system is gravel and earth road well graded and drained and kept maintained, a large mileage of usable road having been the object and not a limited mileage of superior road. This is the solution of their rural highway improvement problem which all South and Central American countries need. In the cities and occasionally for a few miles out of the cities there is call for paved roads, but elsewhere the task is to provide a dirt grade, surfaced when it can be with more resistant local material, but primarily a graded and drained roadbed which the countryman can travel with his produce. Most service to Latin-American road building can be accomplished by keeping these facts clear not only in the minds of the South Americans but by those American engineers who may be called upon for council.

Agree to Progress

QUITE logically, the conference committee of engineers and fabricators appointed to harmonize views on working stresses for structural steel came to early agreement on the figure of 18,000 lb. per square inch as basic unit stress, as reported last week. The conclusion is progressive, and therefore is to be welcomed; advance from the time-honored 16,000-lb. figure was long overdue. During the past year or two technical opinion has become more and more dissatisfied with the traditional limitation of practice. Doubtless the efforts of the American Institute of Steel Construction to bring about the adoption of a higher figure by municipal building departments, as well as the report of the American Society of Civil Engineers committee recommending a 20,000-lb. basic stress for building work, played a large part in furthering this realignment of view. At the same time, their work, and particularly the latter recommendation, challenged careful scrutiny of the steel construction practice of three or four decades to bring forward evidence against higher design stresses under modern methods of engineering and execution of work. Yet no such evidence was brought to light, and the weight of experience thus is in favor of the present recommendation to go to a higher

level of efficiency. The step from 16,000 to 18,000 is conservative and cautious. In the near future further consideration and careful rescrutiny of steel construction experience may show that a somewhat larger advance is warranted to the level of practice of those courageous engineers of the nineties who planned and builded well at working stresses of 20,000 lb. per square inch. For the present, the agreement of the conference committee of the American Society of Civil Engineers and the American Institute of Steel Construction serves notice that steel construction practice needs to be modernized and emancipated.

Moderation in Economy

NO REMARK of a public speaker is received with more enthusiasm by the ordinary group of men than the well-expressed plea that government shall and must reduce its expenditures. Everybody pays taxes; taxes are required to provide the money for the things that government buys; the less government buys the less taxes it will require and the more money everyone will have. It's a simple enough syllogism. No wonder so many people swallow it whole without figuring out to just what extreme it may lead. There is such a thing as productive government expenditure, which this easy theory of economy takes not into account. Not only do these expenditures add to the comfort, convenience and economy of living and by so doing save money—but they require labor and that labor requires material and equipment to the producing of which a whole series of industrial activity is set in train. There is a dilemma of thrift. If everybody saves and nobody spends, where is the money coming from to pay those who make the goods that lie beyond the bounds of bare necessity? So too in government spending. Is this ideal so often held up to us so grand after all? What will it profit us to save millions in taxes if by so doing we also cut down the consumption of goods and the demand for labor? Moderation, as the old philosopher said, is a great virtue—even in public economy.

New York Regional Planning

LAST week's gathering of representatives of a hundred New York, New Jersey and Connecticut communities within the district being covered by the Regional Plan of New York and Environs was a sign of promise. The committee does not even dream that the four hundred communities in the regional area will officially adopt the plan after it is submitted and provide means for carrying it out unchanged. All that can be expected is that the plan, which will be in broad outline only, will serve as an inspiration and to some degree as a guide for the future development of an area whose present eight million inhabitants will soon be doubled and, within the period for which many engineering works are projected, will be tripled or quadrupled. If the committee accomplished nothing else it would have performed a great service through those parts of its studies alone which review past changes, show present tendencies and forecast future needs. Fortunately it will not stop there. It will suggest ways to meet the various needs of the future; not by hard and fast plans for highways, railways, land and water transportation, parks and zoning, but in flexible outlines, readily changed to meet changing conditions and conceptions. Because there can be no finality in city or regional planning is no valid reason against such an undertaking. If it were, it would apply equally against planning a water-works, a sewerage or a park system to meet the apparent needs of the next few decades. Because a broader vision and more flexibility is needed in planning for a whole city or a whole region should only serve as a spur to the engineer, the architect, the captain of industry, the lawmaker and far-seeing citizen.

Individualistic Engineering

OFFICIAL engineers in the West do not seem to be able to meet the views of their local professional brethren in the matter of flood protection. Two weeks ago there were reported in these columns the objections of the organized engineers of Denver to the city's official flood protection plans; in this issue is an outline of the long standing controversy regarding the means to be taken to prevent floods in Los Angeles County.

This Los Angeles case is peculiar to itself, for it represents the persistent resistance of one engineer, in official position, to the local group opinion of the profession and his repeated success, in spite of that opposition, in his appeal to the people of the county for funds to carry on his schemes. It is difficult to tell the whole Los Angeles story without descending to personalities and that is manifestly improper in a technical discussion. But it is a fact that Mr. Reagan has managed for some seven years to defy the best expression of the opinion of the engineers of Los Angeles in this matter of flood protection and at the same time to persuade the citizens to back him up with funds, despite much publicity in opposition by the organized engineers whose interest must be conceded to be altruistic. Now the federal government has been called in, and on what must be admitted to be shadowy grounds has conducted an elaborate investigation of the whole affair.

Just what the government can do in the matter remains to be seen, for the citizens of Los Angeles County manifestly have the right to be as foolish as they want to be in spending their own money for their their own protection, especially as the proposed constructions do not appear to threaten any federal authority or trespass on any federal right. But the government engineers' report may serve to reinforce the position of the local engineers and impress the citizens with the validity of the professional complaint against the county flood-commission's engineering.

Mr. Reagan is a maverick; he refuses to stay within the reservation or to have anything to do with his fellow engineers. For that reason it is difficult to analyze as carefully as one would like the motives or the principles in this case. The weight of the evidence certainly is that Los Angeles is going about this serious business of guarding against flood in curious defiance of some of the well known principles of engineering investigation and that reliance on the sayso of one man is being carried to a point where both economy and safety may be endangered. Los Angeles seems to like dominant personalities in its engineering. William Mulholland for years has been the well loved dictator of its water supply policies and practices. But Mulholland with hardly an exception has had behind him the concerted approval and regard of the engineers of his city.

Too Much Standardization?

OCCASIONAL notes of protest have been heard amid the general chorus of acclaim for standardization during recent years. Dr. John A. Mathews is the latest of the protestors. He charges that we have too much standardization and too little scientific method, or too little of real union between science and industry. Still more sharply does he thrust at the modern movement when he challenges the efficiency of standard specifications:

> I hate to think of the man-hours spent in the last twenty-five years arguing, haggling, disputing, and compromising over so-called standard specifications. Being compromises, they are rarely wholly satisfactory to either producer or user, and they rarely represent the highest class material. . . . I dislike intensely manufacturing down to a specification rather than up to an ideal, in order to meet competition and to remain in business.

These words invite thought. Of the two questions which Dr. Mathews raises, that relating to the lack of sufficient science in industry is so broad and profound that we must leave it for another occasion. But his major thesis, that quality standards are likely to straitjacket progress, is sufficiently important, because of its radical disagreement with popular beliefs. In the powerful drift toward leveling all production through quality standards, it is inevitable that there shall be compromising between the best and the worst; and it is equally inevitable that this compromising will be a foe of quality and improvement and will tend to remove the best from the market. It exalts and hallmarks the mediocre. Specific practical instances might easily be cited; but instead of venturing on this delicate ground we may more profitably refer to an opposite instance, found in one of our most virile and progressive industries.

The automobile industry has remained far from standardization—doubtless because the competitive pressure for improvement, the movement toward better quality and greater efficiency, has inevitably prevailed over all attempts to halt the onward movement by fixing elements of practice that are in constant change. Standardization has, in fact, found its main field in those industries that are least actively engaged in progress. Such industries have many fixed and static practices, and it is an easy matter to compile the local or accidental variations and harmonize them through a compromise standard. But there is always the uncomfortable thought that perhaps this very condition is an indictment of the industry concerned: Were it engaged more actively in self-improvement and practice, it might not be so readily amenable to standardization.

In this connection it may be significant that during the last two decades the steel industry was an extensive subject of quality standardization, and that there have been many complaints that this industry is markedly unprogressive in its attitude toward research and quality improvement. In fact the address of Dr. Mathews from which the above citation is made dealt largely with the severe and greatly varied demands which modern industry makes on the steelmaker and with the need for research and scientific method to meet these new demands. If he did not overstate the situation, it may be that there will be less standardization of steel products in the next ten years or so than in the recent past. And the same thing may hold for other products as well, for every industry is as much adapted to improvement as the steel and automobile industries, and is as greatly in need of building its existence on change rather than fixation. There can be too much standardization.

Debt Paying Unpopular

IF hanging a person in effigy is an expression of dislike, the farmers on the North Platte reclamation project dislike the heads of the federal Bureau of Reclamation. On May 27 they hanged two figures representing Dr. Hubert Work, the Secretary of the Interior, and Dr. Elwood Mead, the commissioner of reclamation, and left them dangling in front of the office of the Water Users' Association, so the Associated Press reported. It appears that the demonstration is a protest against withholding water from farmers who have not paid their charges. Non-payment of water charges is quite a popular amusement on many of the reclamation projects, and North Platte has in recent years been one of the worst in this respect. Temporary remission of debts by act of Congress has been so regular a proceeding that the farmers may have come to believe that they will never have to pay for their water if they resist sufficiently.

The present administration of the Reclamation Bureau has fought hard against this attitude. It has studied the situation of the farmers, listened to their protests respecting injustices or hardships, allowed their claims practically in full, and in return asked simply that they pay for their water and farm efficiently. Yet the farmers continue to protest, in the belief that the game which has succeeded so long will continue to serve. The situation showed itself very plainly last summer on the Boise project, where well-to-do landholders pleaded poverty—even inability to pay a long overdue charge of $15—until it was made entirely clear to them that they could obtain no water and in addition might be foreclosed, whereupon they promptly paid. The North Platte project landholders now make the spectacle more picturesque by hanging the officials *in absentia*. At bottom, however, the difficulty is the same: the federal government is operating a public utility and finds it a difficult matter to collect bills in the face of political pressure and Congressional relief laws.

The Bureau of Reclamation is doing an excellent piece of work in combating the evil results of reclamation politics by making a sincere attempt to collect these bills on the same basis as a private utility. Now, by the irony of fate, the Secretary of the Interior, who began in the pose of the farmers' friend and who discharged the cold-hearted and unbusiness-like engineers to appease the farmers, has reached the point where his putative friends turn on him and hang his effigy to a tree because of his demand that they pay their overdue debts. Dr. Mead, keenly in sympathy with farm problems and indefatigable in his efforts to promote their solution, is hanged with his chief. For both, the incident is a testimonial of good service to the public. For the country at large, it brings to the front the question that has been crystallizing into definite form for some years: Has not the time come to discontinue federal reclamation development and leave the construction of irrigation works to state, local and corporate enterprise?

Baffle Piers at Toe of Dam Dispel Energy of Flow

Precaution Taken Against Possible Erosion of Soft Rock—Layout of Baffle Piers Based on Experiments on Model—Quiet Flow Below Dam Resulted

By I. C. Steele
Chief of Division of Civil Engineering, Department of Engineering, Pacific Gas & Electric Co.

UNUSUAL foundation conditions at the site for the 130-ft. spillway diversion dam for the Pit No. 3 power development of the Pacific Gas and Electric Co., described in *Engineering News-Record*, Jan. 28, 1926, p. 144, influenced the adoption of concrete baffle piers in conjunction with the lining of the river channel to guard against possible scouring and erosion at the toe of the dam.

There being little precedence for such a scheme it was decided to construct a model of the dam and conduct a series of experiments to determine the proper shapes, sizes and location of the piers. These experiments proved to be exceedingly interesting and enlightening and led to the selection of piers and layout considerably at variance with those first proposed.

Geology of the Site—The prevailing rock formations in the Pit River basin are either basaltic or andesitic lavas, lava agglomerate or tuff, which vary within themselves from solid rocks capable of withstanding almost any load to soft friable masses incapable of load.

A thorough investigation of three miles of river channel by means of diamond drill and drift work was made in order to determine the best possible site for the dam. Explorations at the site disclosed four alternating strata of basaltic lava rock and volcanic tuff lying in a nearly horizontal position but having a slight dip downstream. It was evident that the dam would be founded for the major part on the tuff with rock abutments. Tests of small laterally unsupported cubes of the tuff showed it to have an ultimate strength equivalent to from 50 to 75 tons per sq.ft. which was considered entirely safe, since the foundation pressures under the dam are only about 8 tons per square foot. This material is firm, dense and impervious and very resistant to erosion as evidenced by the fact that the river which had cut through the upper rock formation has cut into the tuff to a very small degree.

It was felt, however, that during the alternate periods of wetness and dryness some weathering would take place, also that the tremendous energy from the overpour might erode the tuff if left unprotected. It was not deemed advisable to attempt the construction of any form of stilling pool because of the limited thickness of the tuff stratum and because it was desired to leave intact as much of this impervious material as possible. Further the banks immediately below the dam required protection. Consequently any such form of energy destroyer would be less desirable and more costly than the method adopted, namely, the concrete lining of the river channel for a distance of approximately 150 ft. downstream from the dam and the construction of concrete baffle piers, placed upon and incorporated with the apron.

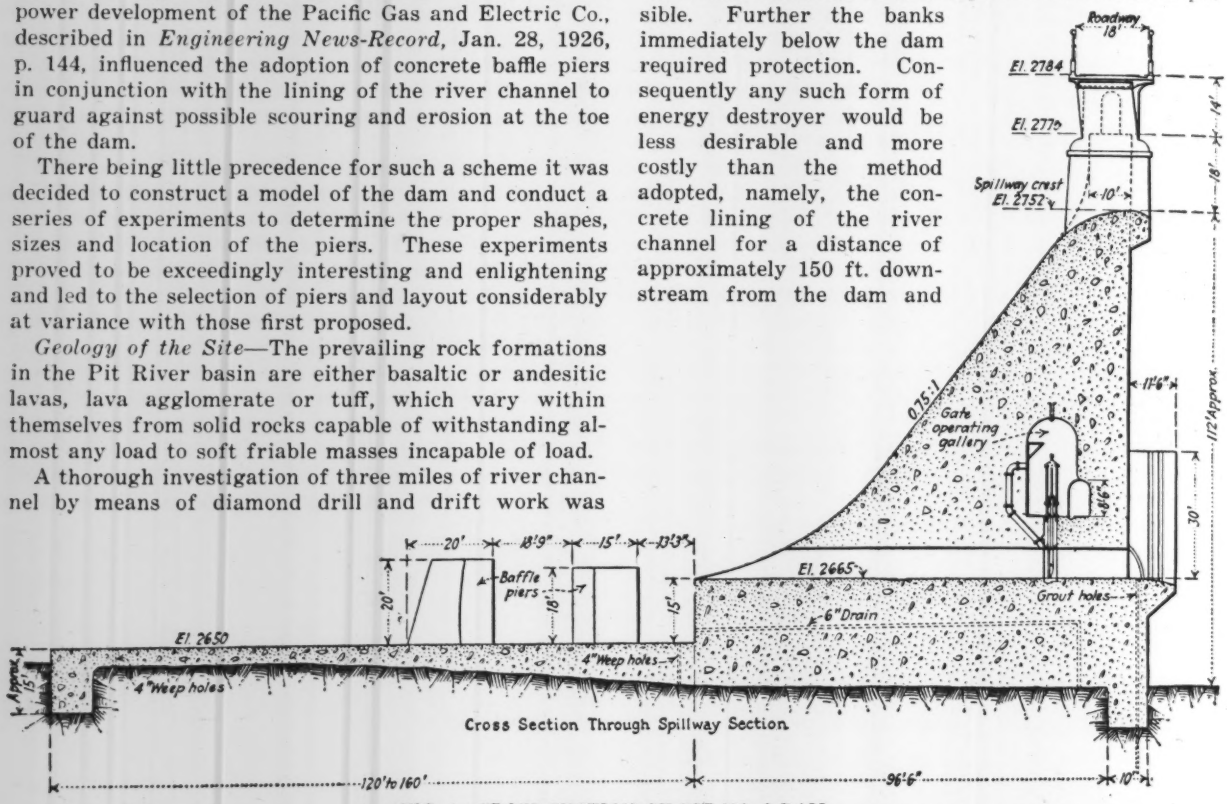


FIG. 1—CROSS-SECTION OF PIT NO. 3 DAM
Showing arrangement of apron, baffle piers and other features

Description of Dam—Pit 3 diversion dam is an ogee spillway type concrete structure 112 ft. in height from foundation level to spill crest with a spillway portion 18 ft. deep and 267 ft. long designed to pass a flood of 70,000 sec.-ft. The dam is arched in plan to a radius of 500 ft. The concrete apron has a minimum thickness of 4 ft. and extends a maximum distance of 150 ft. downstream from the toe of the dam. This apron is constructed at approximately river bed level.

The toe of the dam is designed with a 15-ft. vertical face or jump-off which extends the full width between the concrete wing walls. As will be noted in Fig. 1 the tangent to the curve of the downstream face of the dam at this jump-off is downward rather than horizontal. This was so designed to reduce the base width of the dam and to direct the spillwater at this point so that the stream would strike well down on the upstream, or splitter piers, and downward into any high backwater. If the tangent to the curve were horizontal at

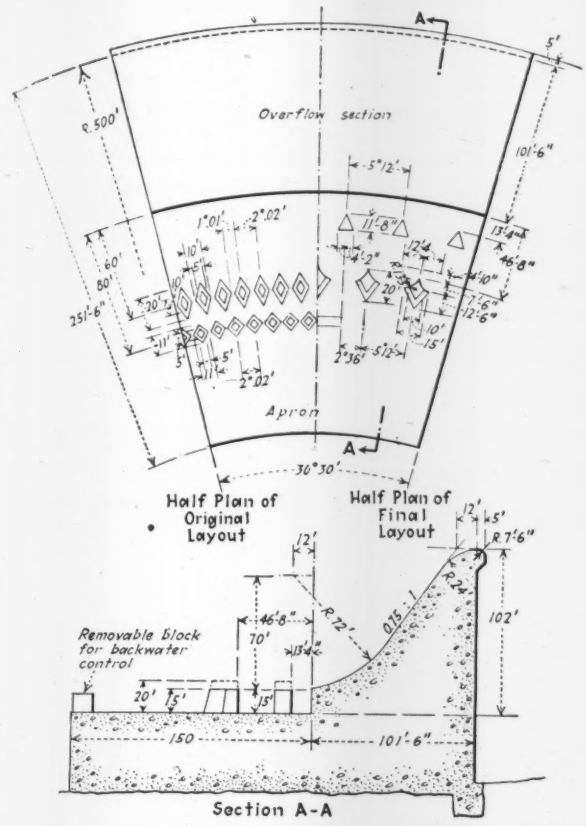


FIG. 2—PLANS AND CROSS-SECTION OF MODEL DAM
Showing original and final layout

this point there would be more of a tendency for the spillwater to jump over the piers thus making them more or less ineffective at the very time they were most needed.

Tests on Model Dam—Advantage was taken in the design and construction of a small concrete diversion dam in Rock Creek, the waters of which are diverted into the Pit No. 3 tunnel, to carry out a series of experiments to determine a suitable system of baffles. This dam was designed and built as a 1/20 scale model of the main structure insofar as features were concerned which related to the problem at hand.

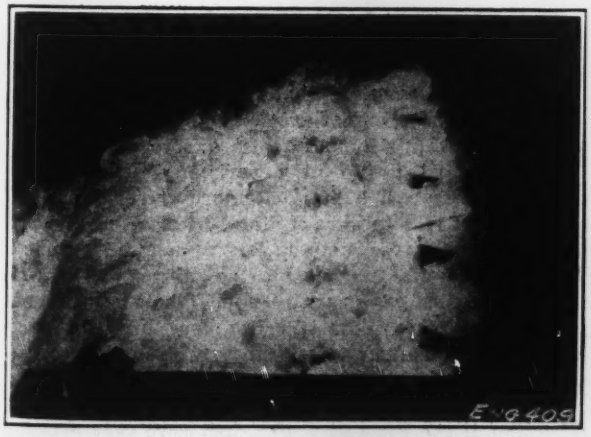


FIG. 3—TEST OF MODEL SPILLWAY
Final layout of piers and 10-foot gage height

A simple removable flashboard arrangement was installed to store water behind the dam in order to secure a maximum head equivalent to 1/20 of that for which the main dam was designed, since the natural flow of Rock Creek at the time of carrying on the experiments was insufficient to maintain the head desired.

While there is some question as to the similarity of action with any given depth of flow over such a model as compared to the action with the full scale structure and its corresponding overflow, it is felt that the results obtained clearly established certain definite facts and that the baffle arrangement as actually constructed will give excellent results.

All figures and tables relating to the model dam are shown herein with dimensions 20 times those used in the experiments and are directly comparable to dimensions as they would obtain for the main dam and baffle pier arrangement.

All experiments shown in Chart II, with the exception of experiment 17, were made with two rows of piers set on arcs parallel to the curve of the front face

CHART I—TYPES AND DIMENSIONS OF EXPERIMENTAL PIERS

TYPE	MARK	HEIGHT OF PIER	PLAN AND DIMENSIONS
Splitter	A	15′	Direction of flow
Splitter	B	15′	Direction of flow
Splitter	C-1 C-2	15′ 20′	Direction of flow
Splitter	D	15′	Direction of flow
Baffle	E	15′	Direction of flow
Baffle	F	15′	Direction of flow
Baffle	G-1 G-2	15′ 20′	Direction of flow

of the dam and the bucket jump-off. The upstream piers were termed splitter piers and those in the downstream row, baffle piers. The piers in the two rows were staggered in all experiments except 17 which was made with only one row using curved baffle piers. Chart I shows the types, shapes and sizes of piers used in the experiments.

During the early experiments an attempt was made to measure with a pitot tube the velocity of the water flowing over the apron. No reliable information, however, was obtainable due principally to the strong eddy currents and foamy condition of the water.

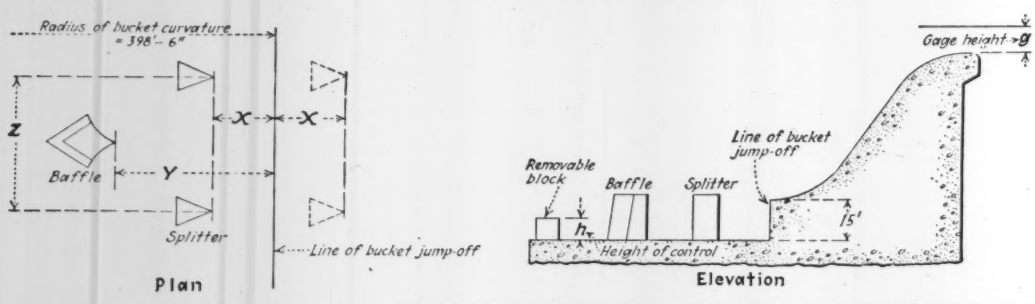
An attempt also was made to take measurements of

the trajectory of the stream below the apron in order to determine by calculation the velocity of the water as it left the apron. An inclined gage was set up for this purpose but it was found that due to the commotion of the water, readings could not be taken with any degree of accuracy.

It was then evident that the best means of obtaining results would be by close observation and notation of the action of the water during the various experiments and by photographic study. The experiments were of the layout as originally proposed and a half plan of the layout as finally adopted. As previously stated all dimensions are shown to a scale 20 times those of the model, thus making these dimensions directly applicable to the main structure. The model was constructed with a free fall below the lower end of the apron, and in order to approximate the back-water effect in a natural stream channel during periods of high water, a control was placed across the lower end of the apron of the model in certain of the experiments.

CHART II—ARRANGEMENT AND SPACING OF EXPERIMENTAL PIERS, RESULTING ACTION AND CONCLUSIONS THEREFROM

Experiment	Piers Used	Gage Height g Ft. and In.	Control Height h Ft. and In.	X Ft. and In.	Y Ft. and In.	Z Ft. and In.	Notes on Stilling Action
1	A Upstream	15–0	0	50–0	74–6	12– 5½	Velocity of water leaving apron very high. Water hurdles second row of piers.
2	E Downstream	15–0	6–8	50–0	74–6	12– 5½	Velocity of water leaving apron very high. Water hurdles second row of piers.
2		11–8	6–8	50–0	74–6	12– 5½	Action not as good as with 15 ft. 0 in. gage.
2		10–0	6–8	50–0	74–6	12– 5½	Action better than at 11 ft. 8 in. gage. Hydraulic jump started at 5 ft. 10 in. gage.
3		....	...	60–0	84–6	12– 1	Hydraulic jump started at 5 ft. 0 in. gage.
4		....	...	30–0	54–6	13– 1½	Hydraulic jump started at 4 ft. 7 in. gage.
5		....	...	50–0	74–6	16– 0	Hydraulic jump started at 5 ft. 5 in. gage.
6	B Upstream	15–0	6–8	50–0	74–6	12– 5½	Water hurdled second row of piers.
6	F Downstream	10–0	6–8	50–0	74–6	12– 5½	Action improved as gage height decreased. Comb of hydraulic jump appeared upstream from piers.
7		9–7	0	50–0	74–6	12– 5½	Action good below this gage. Velocity of water leaving apron still very high.
7		6–3	0	50–0	74–6	12– 5½	Action very satisfactory at this gage and below.
8		....	...	50–0	74–6	16– 0	Water jumped vertically at upstream piers. Hydraulic jump started at 5 ft. 5 in. gage.
9		7–6	...	50–0	74–6	28– 0	Height to which water jumped less than in experiment No. 8, but velocity below piers was greater. Hydraulic jump started at 5 ft. 0 in. gage.
10		....	...	20–0	74–6	16– 0	Water hurdled from upstream piers over downstream piers at high gages, but did not rise higher than in experiment No. 8. Action unsatisfactory.
11	D Upstream	15–0	6–8	11–8	20–0	35– 0	Results very unsatisfactory. Water splashes very high at splitter piers.
11	G-1 Downstream	10–0	6–8	11–8	20–0	35– 0	Results very unsatisfactory.
12		15–0	6–8	13–4	46–8	35– 0	Action better, but still unsatisfactory.
12		11–8	6–8	13–4	46–8	35– 0	Action still better, but unsatisfactory.
12		8–4	6–8	13–4	46–8	35– 0	Action very good for gages below this point.
13	C-1 Upstream	15–0	6–8	13–4	46–8	35– 0	Action excellent.
13	G-1 Downstream	10–0	6–8	13–4	46–8	35– 0	Action excellent.
13		7–6	6–8	13–4	46–8	35– 0	Action excellent.
14		....	...	30–0	50–0	20–10	At high gages, water washed over tops of front piers and hurdled curved piers. Action good at lower stages.
15	C-2 Upstream	....	...	30–0	50–0	20–10	Water did not wash over piers, but jumped 75 ft. vertically from them at gage heights of 13 ft. 0 in. or more. Very good hydraulic jump occurred upstream from piers and between rows below 9 ft. 2 in. gage heights.
16	G-2 Downstream	....	...	30–0	99–0	21– 3	Action good. Curved piers cause good stilling action.
17	G-2 Only	15–0	6–8	46–8	....	35– 0	Action good, but does not compare with that used in experiment No. 13.
18	C-2 Upstream G-2 Downstream	....	...	20–0	40–0	35– 0	Additional piers 7 ft. 9 in. square placed diagonally 5 ft. from jump off at 21 ft. centers. Action good. Splashed to 45 ft. height.



therefore carried on in this manner and the notes and photographs carefully observed. Additional check experiments were then made to finally determine the scheme which appeared to give the best results.

The experiments were made with various arrangements using three main groups of piers as follows:

(1) Originally designed truncated pyramid shaped piers.

(2) Prisms or diamond shaped piers.

(3) Combination of triangular prism piers and piers with curved upstream faces approximating an impulse wheel bucket in horizontal cross-section.

Chart II gives the spacing and types of piers used for each of the 18 experiments, the gage height or depth of overflow, the control height and remarks relating to the observed results.

Fig. 2 shows the cross-section of the model, half plan

To summarize it might be stated that:

1. The first group of experiments using truncated pyramids gave very unsatisfactory results, the water leaping very high in the air as it left the splitter piers.

2. The second group of experiments using prism piers gave better results but still unsatisfactory.

3. The third group of experiments using curved baffle piers showed a marked improvement in stilling action. Best results were obtained by locating the splitter piers close to the jump-off. Experiment 11, made to determine the effect of placing the splitter piers on top of the jump-off, gave poor results. The water in coming against these piers splashed very high on either side and in a manner very similar to the side swash at the bow of a fast moving boat.

The layout as finally adopted in the design and construction of the Pit 3 diversion dam gave very excellent experimental results. The water flowing over the lower

end of the apron was comparatively quiet for all gage heights and from all appearance no more harmful than the natural stream would be in time of high water. The action with a 10-ft. depth of overflow is shown in Fig. 3,

FIG. 4—COMPLETED DAM SHOWING PIERS AND JUMP-OFF

a photographic view taken during experiment 13. This view is typical of the action of the water for all gage heights. Fig. 4 shows the completed dam and piers.

The field experiments and compilation of data were carried on by G. C. Green, field engineer, Department of Engineering, Pacific Gas & Electric Co., and his assistant, A. W. Kidder.

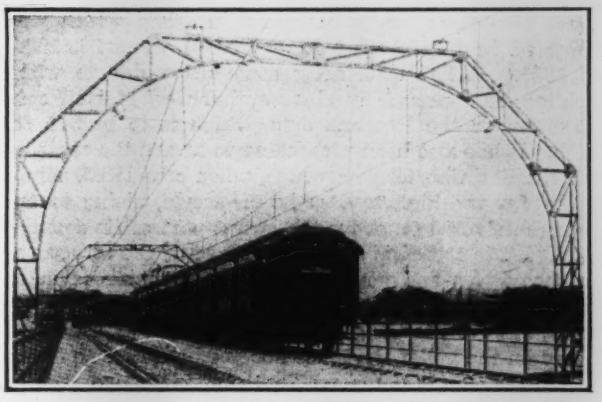
Riveting and Welding Compared in Rotary Kilns

STUDIES of stresses and service factors recently carried out on a set of three rotary kilns for lime burning bring out certain phases of economy and efficiency in steel structures of this type. The studies were made with a view to comparing the strength and behavior of riveted and fusion-welded joints. E. E. Thum, of the Linde Air Products Co., reported the results before the American Welding Society at its convention on April 22.

The kilns are 125 ft. long, 8 ft. in diameter, built of ⅝-in. plate; two of them are riveted and the third is gas welded in both longitudinal and circumferential seams. In the riveted kilns, the longitudinal seams are double-riveted butt joints, the circumferential seams triple-riveted butts; the empty kiln with lining weighs 360,000 lb. The normal bending stress in the shell was found to be 3,000 lb. per sq.in. at midspan and over the supports, while the maximum, when a collar of sintered material had formed near the hot end, was 4,700 lb. per sq.in. These stresses, of course, reverse during the rotation of the kiln. Extensometer measurements were made by T. W. Green. His results checked the computed stresses in the solid plate, but across the riveted joints showed movements more than twice as large as the elastic stretch, indicating slip of the joint. It is reported that such kilns commonly develop loose rivets after service, and apparently this is the principal reason for keeping the shell stresses so low. In the welded kiln shell no such local excess of strain was observed. This kiln had the same shell thickness, its construction apparently having followed riveted practice closely. The author suggests that a reduction of shell thickness to ½ in., which would raise the greatest bending stress to only 5,600 lb. per sq.in. would save 8 tons of steel per kiln and a considerable item of cost in fabrication.

India's First Electrified Railway

IN 1925, the railway system of India had its first stretch of electrification put in service. This is the local and suburban loop line of the Great Indian Peninsula Ry. at Bombay, extending from the Victoria terminal station to a connection with the main line at Kurla, 9½ miles. The line has grades of 3 per cent and a ballasted-deck steel viaduct 1,730 ft. long. An electric train on this viaduct is shown in the accompanying view. On the main line electrification is to extend to Mahim, 10 miles, and through Kurla east to Kalyan, about 40 miles (*Engineering News-Record*, Sept. 21, 1922, p. 485). Suburban trains have motor cars and trailers 68 ft. long, with the unusual width of 12 ft. Electric power purchased from the Tata Hydro-



SUBURBAN ELECTRIFICATION AT BOMBAY, INDIA

Electric Co. is transmitted at 22,000 volts and converted to 1,500-volt direct current for the trolley line. Merz & McLellan are the consulting engineers.

Similar electrification is approaching completion on the Bombay, Baroda & Central India Ry. from its new Church Gate terminal station at Bombay through Mahim to Borivli, about 21 miles. This improved local service on the two railways is established to handle heavy passenger traffic which is expected to result from housing projects being carried out by the Bombay Improvement Trust to relieve overcrowding in the city.

Other electrification projects now under consideration include the suburban lines at Calcutta and Madras and two main line sections of the Great Indian Peninsula Ry. from Kalyan north to Igatpuri and southeast to Poona, 85 and 120 miles respectively from Bombay. Both of these lines have grades of 2.75 per cent. Reduced operating expenses are the main reasons, but with the higher speeds practicable there will be a saving of about 1½ hours in time of trip between Bombay and Poona. All lines have Indian standard 5½-ft. gage.

Flood Control Controversy in Los Angeles County

Engineers Question Policy that Proposes 500-Ft. Dam at Forks Site—Situation Reviewed Before Committee of Federal Engineers

AMONG engineers of southern California there has long been strong disapproval of the methods by which the Los Angeles County flood control work has been planned, but due, presumably, to the reluctance to enter public controversy which is characteristic of the engineering profession, they have not been aggressive in combatting the policy to which they objected. Hearings recently held in Los Angeles before a committee of federal engineers have changed all this; that is, the situation has thereby been brought into the limelight and the differences of opinion have been aired. The case is of general interest because of the unprecedented size of the proposed dam and the unusual number of engineers that have been drawn into the controversy. A news report of the hearing appeared in *Engineering News-Record*, March 25, 1926, p. 501. Some of the high lights of the controversy together with reference to the remarkable history of the county's flood control organization are given in the following.

In the several years since the first funds were made available for flood control work in Los Angeles County the flood control district has completed several of the dams comprised in its extensive program which was reported in *Engineering News-Record*, June 26, 1924, p. 1089. It has also, after some delay due to withholding of approval by state authorities, started construction on the Pacoima dam, which is to be 375 ft. high. It has also been proceeding to award the contract for the San Gabriel dam which, when completed, would be by far the highest dam in the world, rising to approximately 500 ft. above the lowest part of its foundation. Little criticism has been offered of the structures in themselves and no criticism of the construction of those which have been erected. There has been objections, however, to the general scheme of flood protection based on the belief that it is not good practice to locate and design such dams without comprehensive studies of the hydrology of the streams involved and an application of the data obtained in such studies in working out the requirements of economical flood control. Further than that, there has been a direct issue of opinion regarding the location of the dam on the San Gabriel River.

As stated in the news report in the issue of March 25, 1926, p. 501, the city of Pasadena is considering a plan for developing a 65,000 acre-ft. storage project at a point 6½ miles downstream from the fork where the Los Angeles County Flood Control District has located its San Gabriel dam. Pasadena sought to have the construction road or railroad which had to be built into the fork site located well above the flow line of the reservoir which its storage project would effect and the controversy over this question is what led to the appointment of the federal commission of engineers. Meanwhile, however, a number of engineers in southern California have been urging that a more favorable site for the flood control dam would be at a point 7 miles downstream from the fork site at a location known as Granite Dike and a number of opinions as to the relative value of the two sites were offered to the federal committee.

This committee was appointed by the Secretary of the Interior and the Secretary of Agriculture and consisted of F. J. Safley, chairman, U. S. Land Office; F. E. Bonner, U. S. Forest Service and H. D. McGlashan, U. S. Geological Survey. Theoretically, at least, the interest of the federal government lies only with the use of the right-of-way over federal land. The committee, therefore, began its work late last fall by holding informal sessions with different interests involved, hoping to reach some generally acceptable solution, but the problems proved to be so complex that informal sessions were inadequate. The program was therefore changed and the formal hearings conducted in the manner usual in civil courts were begun in February and concluded March 31.

These hearings were originally understood to contemplate only an issue between the city of Pasadena and the Los Angeles County Flood Control District as to right-of-way to the district's proposed $25,000,000 dam at the Forks site on San Gabriel River, but this question was inseparably involved with the whole matter of the district's policy in determining the location and capacity for this dam. A very large percentage of the evidence offered at the hearings, therefore, related solely to the fundamental question of whether it was advisable to locate a dam at the Forks site, as provided in the district's plan, and thus reasons for much of the opposition to the district's methods were brought out on the witness stand.

The fundamental differences between the engineering profession and the Flood Control District appear to be in the question of whether the district has prepared its program with due regard to established principles of engineering; more specifically, whether this program has been prepared with (1) adequate attention to the hydrology of the streams involved, (2) proper consideration and comparison of alternate dam sites, (3) a thorough study of the economic justification of proposed works and (4) the comprehensive engineering studies that are essential to avoiding waste of funds in a program as extensive as that proposed.

History of District—The history of the work of the county flood control organization contains several notable departures from the recommendations of engineers whose judgment would ordinarily be accepted and followed. At the outset, in 1914, when the county supervisors decided that engineering advice was needed in the preparation of a comprehensive flood-protection program, a board of engineers was selected to formulate such a plan. This board consisted of H. Hawgood, C. T. Leeds, J. B. Lippincott, F. H. Olmsted, and J. W. Reagan, the present county flood control engineer. This board prepared an exhaustive report which was brought out in July, 1915, signed by the entire board except Mr. Reagan. A résumé of the recommendations in this report appeared in *Engineering Record*, Aug. 14, 1915, p. 204, and Aug. 21, p. 232.

Mr. Reagan then brought out a minority report which other members of the board had not previously seen and which showed him to be not at all in accord with the policy of the majority. The majority favored reforestation, the construction of check dams, small flood control reservoirs and the general policy of redistributing

waters as much as possible to control the floods and replenish underground storage supplies. They made no recommendation in favor of structures that would be unused a very large part of the time and believed it unwise to set up as a primary objective the construction of large flood channels to the sea or the use of very large reservoirs which, in this region, would be unduly expensive.

In view of the experience and ability of the four engineers who agreed on the majority report, the subsequent action of the county board of supervisors in completely disregarding their recommendations and accepting the contrary policies of Mr. Reagan came as a decided surprise. The appointment of Mr. Reagan as flood control engineer was announced in September, 1915.

The second victory for Mr. Reagan came early in 1917. On Jan. 2, 1917, he submitted a report proposing a $4,450,000 bond issue for flood control work in which he stated that the plan "would control and conserve the flood and storm waters of the district for beneficial use and protect the Los Angeles and Long Beach harbors, waterways, public highways and property from flood damage."

Recognizing the discrepancy between this and the earlier report of the advisory board recommending an estimated expenditure of $16,000,000, the City Council, the Chamber of Commerce and the Municipal League selected a committee of three engineers of high qualifications to examine and report on the design, adequacy, character and cost of the work outlined by Mr. Reagan. The report of this committee said in substance, "Much of the work contemplated is not permanent and its certain failure will discourage future efforts. . . . The plans as a whole would inadequately meet the flood control problems of the district." The committee further pointed out that Mr. Reagan had almost entirely neglected the fundamental principles of proper flood control, namely, minimizing erosion and increasing the absorption of rainfall in the mountains by cutting off the high peaks of the floods with regulating reservoirs and by low restraining dams at frequent intervals. Despite this adverse recommendation of a capable committee of engineers the $4,450,000 bond issue carried on Feb. 20, 1917, by a very small majority (a two-thirds vote not being required, as is usually the case).

The third departure from what might be considered usual procedure came early in 1924 when adverse recommendations of the local chapter of the American Society of Civil Engineers went unheeded and voters of Los Angeles County in May, 1924, approved by a heavy majority a $35,300,000 bond issue for carrying out Mr. Reagan's program of flood protection works.

Meanwhile, work has been carried on as stated in the earlier paragraphs and criticism of the plan has been steadily increasing. This criticism is mainly that the taxpayers' interests are not adequately protected and are without the benefit of highly desirable engineering direction in the planning of the work, when the hydrology of the streams and the economics of the flood control problem as a whole, are dismissed lightly or neglected altogether. Examples of the policy to which exception is taken appear in Mr. Reagan's testimony at the hearing; for example, in his declaration that he would recommend building a dam 425 ft. high above streambed costing $25,000,000 even though a dam of this height would store 400,000 acre-ft. instead of the 240,000 acre-ft. now proposed. Similarly he is reported to have stated that he had decided upon the size of the dam by selecting a total height above foundation about 100 ft. greater than the highest concrete dam previously built.

Comparison of Sites — The testimony of eminent geologists, notably that of Dr. John P. Buwalda, showed clearly that the geological conditions are very much the same at the Forks and the Granite Dike sites. Mr. Reagan explored by diamond drill borings the foundations at the proposed Forks site but did not similarly explore other possible sites somewhat lower down on the same stream. On this point it is of interest to note the summary of conditions and the conclusions prepared by Louis C. Hill when retained by the California Taxpayers' Association to make a comparative report on the advantages of the two sites. The following is taken from Mr. Hill's report:

Points in Favor of Forks Site:

(1) Unnecessary to buy land or to pay royalty in order to obtain aggregates, and the supply of aggregates is within one-half mile of the site as compared to two miles at Granite Dike.

(2) More room for camps and disposal of waste.

(3) Known geologic conditions at the Forks, as compared to the necessity of several months of foundation exploration at Granite Dike.

(4) Fewer rights-of-way complications.

(5) No submergence of Southern California Edison Co.'s conduit.

(6) Unless débris detritus dams should be built on each fork of San Gabriel River above the Forks site, the construction of a dam at Granite Dike would cause large amounts of detritus to be deposited over the forks site, which would greatly increase the cost of construction of a dam at the Forks site at some time in the future.

(7) If the location of the dam is changed from the Forks to Granite Dike, it may be necessary to call another election.

Points in Favor of Granite Dike Site:

(1) Estimated saving of 700,000 cu.yd. of excavation.

(2) Estimated saving of 870,000 cu.yd. of concrete.

(3) Only 4 miles of new railroad from Azusa to the Granite Dike site.

(4) Saving of a year to 18 months in time of construction.

(5) Better spillway conditions which permit the overflow to be discharged into the river about half a mile below the dam.

(6) The sand and gravel bar from which the supply of aggregates would be obtained is below the dam, which would permit storing water before the dam were completed.

(7) Equal control of the maximum floods, and better control of the river in all other years.

(8) Reasonable certainty that the cost of a dam at Granite Dike will be less than the $25,000,000 voted for a flood control and conservation dam on the San Gabriel River, against the probability that additional bonds will be required to complete the dam at the Forks site.

In conclusion, Mr. Hill says: "From such information as is available at this time, a dam creating a reservoir of 240,000 acre-ft. capacity can probably be constructed at Granite Dike for at least $6,000,000 less than an equivalent dam at the Forks. Interest on this amount during the period of retirement of the bonds (4½ per cent, 40-year serial bonds) would bring the additional cost of the Forks dam to a total of $13,000,000.

"If the Granite Dike site is properly investigated and if such exploration of this dam site should prove it

unsatisfactory, then the time required for investigation might be considered as lost. However, if the investigation proved the lower site satisfactory, there would be an actual saving in time."

Mr. Reagan defended his selection of the Forks site over other possible locations, notably the Granite Dike site, and offered considerable evidence calculated to show the unsuitability of the latter site. In view of the testimony of geologists that both sites are on a par as to security of foundation conditions, it has been suggested that the net result of this testimony on the public mind may be a reaction against the construction of a large dam at either of the proposed sites.

The disagreement between the engineering profession and the Flood Control District has now crystallized into a test case in this controversy over the large item of the San Gabriel dam. The opposing engineers take the position that this is a typical instance of the waste that can result from the planning of such works without adequate engineering study. Thus the committee of federal engineers with evidence before it which has not previously been made public is in a position to write, in its report, which should be made public soon, the next chapter in the history of this unusual case.

Observed Stress Distribution in Web of I-Beam

One-inch Gage Used in Three-Directional Strain Measurements—Cross Stresses Found Important

By O. H. Basquin
Professor of Applied Mechanics, Northwestern University, Evanston, Ill.

Experimental measurement of web stresses in an I-beam was undertaken at Northwestern University last year under the direction of the author, the measurement being carried out by C. G. R. Johnson and R. L. Ward, students in the College of Engineering. The main purpose was to investigate the variation of longitudinal (flange) stress, transverse stress and shearing stress near load or reaction points, where it has been suspected that our conventional theories of design are far from representing actual stress conditions.

The investigation was made possible by the availability of a highly precise strain gage working on approximately 1-in. gage length. With this instrument strain measurements taken in three directions at each measuring point—vertically, horizontally, and on the bisecting line—enabled the desired stresses to be computed, by a method as follows:

Method—If three very short gage lines are arranged as shown by detail in Fig. 1, on the flat free surface of an isotropic material whose elastic constants are known, and if the linear strains of these lines are found for a loading under elastic conditions, these strains enable one conveniently to determine the complete systems of strain and stress for the point at which the lines intersect.

Let p_1 and q_1 be the normal and shearing stresses on a plane perpendicular to line 1; let p_2 be the normal stress on a plane perpendicular to line 2; and let E and $1/m$ represent Young's modulus and Poisson's ratio; then the linear strains e_1, e_2 and e_3 of lines 1, 2 and 3 are given by $e_1 = \frac{p_1}{E} - \frac{p_2}{mE}$; $e_2 = \frac{p_2}{E} - \frac{p_1}{mE}$; and $e_3 = \frac{e_1 + e_2}{2} + \left(1 + \frac{1}{m}\right)\frac{q_1}{E}$. These equations may be solved for the stresses, giving

$$p_1 = \frac{E(e_1 + e_2/m)}{1 - 1/m^2}; \qquad p_2 = \frac{E(e_2 + e_1/m)}{1 - 1/m^2};$$

$$\text{and } q_1 = \frac{E(e_3 - e_1/2 - e_2/2)}{1 + 1/m}$$

With these stresses found, the complete system is readily obtained. If one wants the principal stresses instead of the particular stresses used here, he can write relations which will give them directly, and the directions of the principal axes are readily found.

Strain Gage—About a year ago the Northwestern gage was developed in this college and a number of them

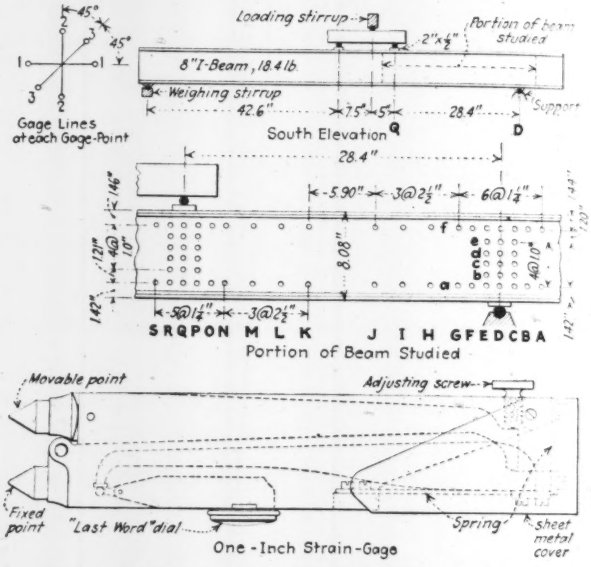


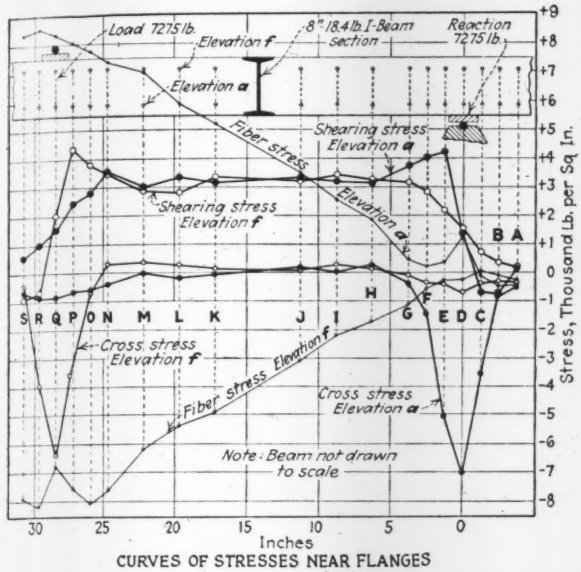
FIG. 1—TEST BEAM, WITH GROUPING OF STRAIN READINGS FOR WEB TESTS, AND 1-IN. STRAIN GAGE

constructed by our instrument maker, Mr. West. The gage comprises a rugged steel frame brazed together, a heavy loose lever with gage point, a light swinging lever supported by two thin flat springs set at right angles, and a "Last Word" dial. The dial has a maximum range of 0.035 in.; the lever system has an effective multiplying ratio of about 50, which reduces the maximum measurable variation in gage length to 0.0007 in.; but the initial lengths of gage lines may vary from about 0.99 in. to about 1.01 in., a variation about 30 times the measurable range. To accommodate these conditions, the loose lever has cylindrical shoulders in rolling contact with flat faces on the frame, and the point of contact is freely adjustable to the length of the gage line. The gage is held to its line by means of a frame which applies a force of about 50 lb. directed closely toward the middle of the gage line; after the loose lever has been adjusted to the gage length, it is this force, in combination with friction, that maintains the adjustment. A sketch of the gage is included in Fig. 1.

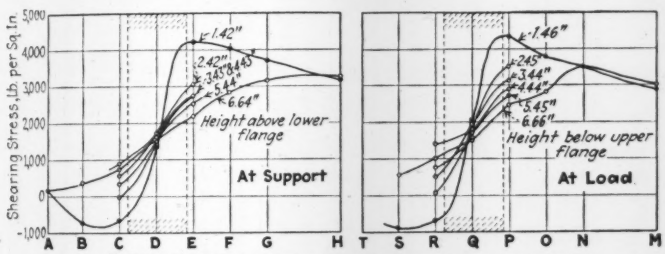
Beam Tests—The beam web subjected to the test was the end portion of the web of an 8-in., 18.4-lb. I-beam about 7 ft. long between supports, loaded by a two-point loading as indicated in Fig. 1. The web

in the length of 28.4 in. between one support and the nearest load point was studied, together with small adjoining parts of the web. On the face of the beam shown by the sketch, which was the south side of the beam, a system of gage points was laid out, spaced generally about 1 in. apart vertically and 1¼ to 2½ in. horizontally. Each point thus defined was used as the center of a system of three gage lines as shown by the small diagram, for determination of the several stresses at that point. A corresponding system of points was laid out on the other face of the web.

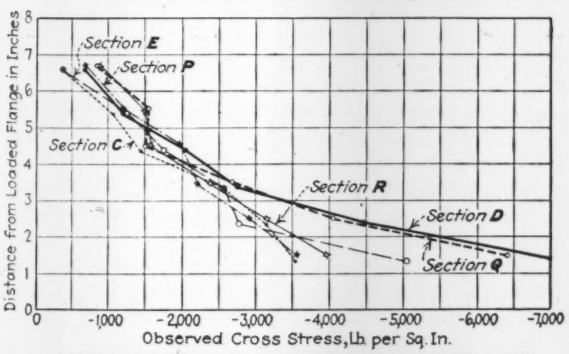
Readings at each gage point were always taken simultaneously on the two sides of the beam, one reading at initial load of 150 lb. and another reading at 5,000 lb. The change in reading was reduced to strain for each side, and the values for the two sides averaged. The above process constitutes one determination for a single line. The study covered 186 lines on each side of the beam. To obtain the strains 705 determinations were used, and several determinations were made and rejected as unreliable. The determinations averaged 3.8 per line; the smallest number per line was 1 and the largest was 17; the single minimum was for line 3 at station *Cc*, and the single maximum for line 3 at station *Pf*.


Load 7275 lb.
Elevation f
8" 18.4 lb. I-Beam section
Reaction 7275 lb.
Elevation a
Fiber stress Elevation a
Shearing stress Elevation a
Shearing stress Elevation f
S R Q P O N M L K J I H G F E D C B A
Cross stress Elevation f
Fiber stress Elevation f
Cross stress Elevation a
Note: Beam not drawn to scale
Stress, Thousand Lb. per Sq. In.
Inches

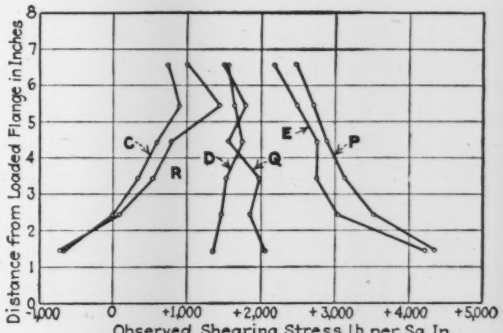
CURVES OF STRESSES NEAR FLANGES



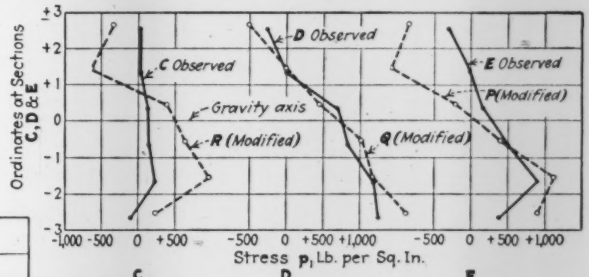
SHEARING STRESS: EFFECT OF HEIGHT FROM LOADED FLANGE



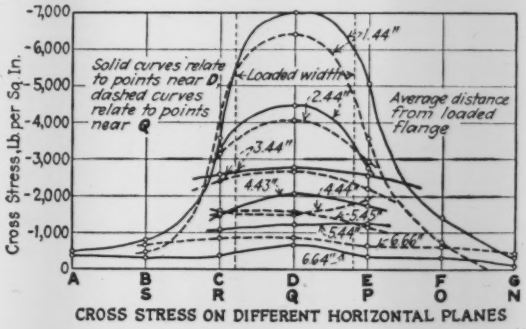
CROSS STRESS: EFFECT OF HEIGHT FROM LOADED FLANGE



SHEAR VARIATION ON DIFFERENT VERTICAL SECTIONS



COMPARISON OF FIBER STRESS AT SUPPORT END OF LOAD



CROSS STRESS ON DIFFERENT HORIZONTAL PLANES

FIG. 2—STRESS DISTRIBUTION CURVES AT VARIOUS SECTIONS AND ELEVATIONS OF THE BEAM WEB, FOR LONGITUDINAL STRESS, CROSS STRESS, AND SHEAR

For sections C, D and E the lower flange is the "loaded flange." For sections P, Q and R the upper flange is the "loaded flange."

In deriving stresses from the observed strains, it was assumed that Young's modulus is 30,000,000 lb. per sq.in. and the Poisson's ratio is 0.250. For any station the strains for lines 1, 2 and 3 are denoted by e_1, e_2, and e_3, respectively, expressed in parts in 100,000, positive for extension. The relations used for deriving the corresponding stresses are:

$$p_1 = 80(4e_1 + e_3)\,;\; p_2 = 80(e_1 + 4e_3)\,;\text{ and}$$
$$q_1 = 120(2e_2 - e_1 - e_3).$$

In the detail calculations account was taken of slight variations of the dimensions of the beam from its nominal dimensions. The web thickness ranged from 0.267 to 0.277 in., being about 0.269 along *a* and *f*, and about 0.273 in. in the main part.

In Fig. 2 are grouped various diagrams representing

the stress variation determined by plotting of the resulting readings. At the left is shown a plot of the variation of stress in the length of the beam, between support and load, two lines showing the longitudinal stress at elevations *a* and *f* respectively (near lower and upper flanges) and other pairs of lines showing variations of cross stress and shearing stress at the same elevations. These indicate the general regularity of longitudinal stress, with, however, decided irregularities at the load and reaction points. At these same points the shearing stress also shows a rise. The cross stress (vertical tension or compression) is negligible except for distances up to 3 or 4 in. from load point.

A separate diagram sketches the variation of shearing stress on horizontal planes at different distances from the loaded flange. Conditions at the supports and at the load points are closely in agreement. It will be seen that, contrary to ordinary design assumptions, the shearing stress is much greater in that part of the web nearest the loaded flange than near the unloaded flange. The variation of shearing stress is further brought out by plots of shear variation on different vertical sections.

The important variation of cross stress is outlined in the following diagram, where it is plotted separately for horizontal planes at different distances from the loaded flange, and this variation is plotted in another way for the two vertical sections at the support and at the load point in function of the distance from the loaded flange in the following diagram.

The last diagram shows a comparison of fiber stresses near the support with the fiber stresses near the load, after subtracting from the latter the stresses due to bending, estimated from the equation

$$p = -3327y$$

in which y is the ordinate from the gravity axis.

While this method of estimating stresses from strain-gage readings has been in use in our laboratory for several years, this is the first serious application of it to the study of stress distribution in steel beams, and this attempt is regarded principally as a reconnaissance.

It appears to indicate that there is no serious difficulty in measuring strains on 1-in. gage lines to about one part in 100,000.

It calls rather forcible attention to the cross stress as having a real existence at certain parts of a beam, and as worthy of attention along with fiber stress and shearing stress. A picture that appears to be fairly consistent is given of the development of shearing stress in the web near loaded sections, a rapid development near the loaded flange and a slow development near the opposite flange. The diagram of longitudinal stress variation shows a tensile fiber stress of 1,250 lb. per sq.in. at station *Da*, where one would expect the fiber stress to be very small. At this station the value found for cross stress is —7,000, compressive; the average value of the cross stress over the length of the horizontal gage line (1) may be estimated as, say, —6,000; one would then expect the strain for line 1 to be too small, and the error in the fiber stress to be negative instead of positive. A similar effect is shown at station *Qf*. It is not clear to what extent these modifications of fiber stress are genuine.

To make a trustworthy interpretation of the results obtained will require considerable study. It is thought that this may well await the results of tests with larger beams and more numerous stations.

Highway Types and Upkeep Costs in Porto Rico

Steady Road Betterment Evident Since American Occupation; Original Macadam Now Being Surfaced; Upkeep Costs Cited

By F. Lavis
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IN an editorial in *Engineering News-Record* of March 25, 1926, p. 421, referring to the recent Pan-American Road Congress, occurs the statement: "The first and greatest service will be to see that the new road-building countries are not led into extravagances of paved and costly surfaced roads. Mileage is what most Central and South American countries want first—graded dirt roads and gravel and stone surfaced roads which will open up the farm lands and forests."

Nothing could be more apropos and the warning is timely and necessary. There will be a tendency in all these countries to build nothing but the best, that is, the most expensive, to follow our practice either of heavy concrete pavements or wide boulevards.

The writer recently had occasion to visit the island of Porto Rico and noted with interest not only the excellent condition of the roads there but the very able way the program of road building in the island is being carried out. The work is a most excellent example of true economy and the proper adaptation of the type of work to the conditions to be met.

It will be recalled that Porto Rico came into possession of the United States in 1898 after the war with Spain, and at that time it was in much the same condition in regard to road construction as most of the other Latin-American countries were then and indeed very largely are today. There was, however, in existence at that time the military road between San Juan, the capital, and Ponce, on the other side of the island, the second city in importance. This was a waterbound macadam road about 16 ft. in width and was generally quite well maintained.

Porto Rico is generally hilly to mountainous. The mountains are not high, ranging throughout the island from 1,500 to 3,000 ft., and the character of the roads is that required and natural in a mountainous country, that is to say, they are very tortuous, almost entirely on curves, and in many places with considerable development, where the location winds back and forth on the side hills in making the climb or descent.

Porto Rico, of course, is in the tropics, subject at times to the intense tropical heat and to continuous downpours of very heavy rain during the rainy season. For those who live in Porto Rico the tropical heat is tempered by the trade winds, which make the climate almost ideal to live in. Insofar as the highways are concerned, however, they must stand the really intense heat of the direct rays of the sun beating down almost perpendicularly on the pavement. In the rainy season it may not rain every day, and usually does not rain in the morning, but here again, so far as the roads are concerned, they are practically continuously wet and subject to very heavy downpours. These are the conditions which the roads have to meet.

Since the beginning of the American occupation it has been the policy of the government to make yearly

extensions to the road system, and today the island is pretty well covered by a network of roads, totaling in all about 1,500 kilometers (900 miles).

The roads have been built entirely of waterbound macadam but are now being coated with asphalt. In application, the asphalt is heated in ordinary sheet-iron kettles and is poured hot in a thin coating over the top of the macadam; then sand or fine gravel or decomposed rock is spread over the surface until no free asphalt works through under action of the traffic. The resulting asphalt coat is from ½ to ¾ in. in thickness.

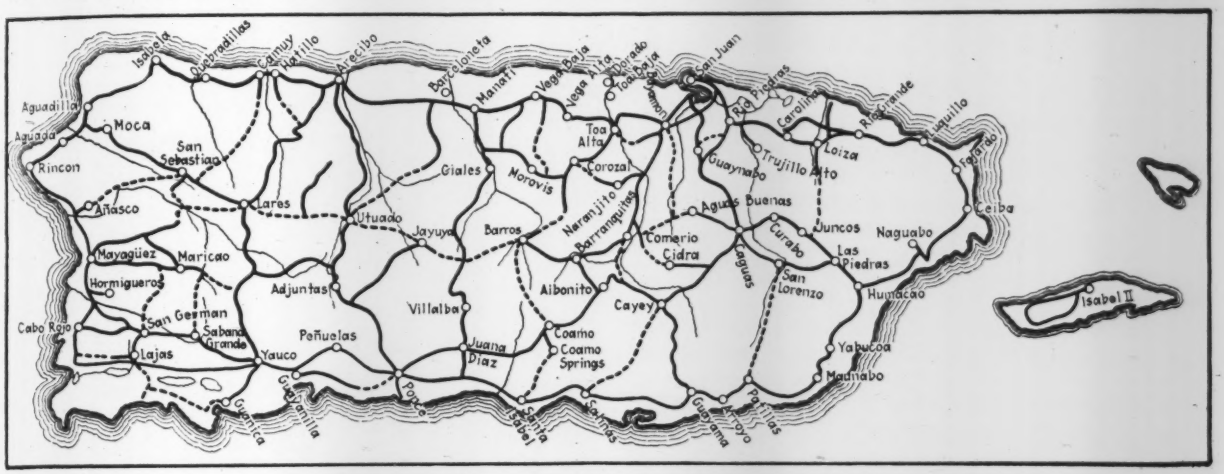
Generally speaking, the roads which the writer saw were in quite good condition. A very rough guess would be that, of those travelled over, over 50 per cent might be classed as very good, 25 per cent good and the rest from good to fair. This must be understood by the government engineers is approximately as follows:

	Cents Per sq.m.
Telford	20 to 40
Surfacing	20 to 30
Asphalt Coating	16 to 22
Total	54 to 92

These figures are contract prices and do not include the government overhead or engineering supervision.

The government engineers state that costs of maintenance are difficult to ascertain. Road menders get from $1 to $1.50 per day and look after 2 to 3 km. each, with a section foreman at from $60 to $75 per month looking after 18 to 30 km.

When asphalting the surface was first started it was assumed that complete resurfacing would be required



COMPLETED AND PROPOSED HIGHWAYS OF PORTO RICO

to be simply the impression of a somewhat hurried trip over about 150 miles.

The interest, of course, is in the economic aspect of this type of pavement and its practical utility. It is very evident that the roads are entirely practical for the purposes for which they are used and support a fairly heavy automobile traffic with a good proportion of heavy trucks. There is no question also that they stand up well under the climatic conditions described.

It goes without the saying, of course, that they are well drained and the ditches are ample and kept clean. In general, the subsoil conditions are good. The rock used is mostly limestone of good quality; along the coast coral rock is used in some cases and gravel from the beaches in others. Labor costs from $1 to $1.50 per day and the maintenance men cover about two or three kilometers each on main roads. The continuous maintenance system is used, the men taking care of the little holes as they appear, keeping the ditches clean, weeds cut, etc.

The roads are generally of three types, having the following dimensions in meters:

	Width over shoulders Meters	Width of pavement Meters
Class 1	8	5.50
Class 2	6	4.50
Class 3	5	4.00

The pavement on earth consists of 0.20 m. of telford and 0.10 m. of surfacing—in rock 0.15 m. of heavier stone is placed instead of the telford.

The cost of the pavement for new roads, as given one every eight years, but it is believed now that the life of this surfacing will be longer than that, although no figures are available. Surfaces which have not been asphalted have to be completely resurfaced on an average about every three years. The first year after resurfacing 10 cu.m. per kilometer are allowed for patching and after that about 100 cu.m. per kilometer.

The cost of maintenance per kilometer from 1903 to 1916 varied from $200 to $300 per kilometer. Since 1916 it has risen to about $800.

The number of motor vehicles increased from 5,720 in 1919-1920 to 10,263 in 1923-1924. Of the latter there are about 2,000 trucks and many buses.

For surfacing, Trinidad asphalt is found to give the most satisfactory results but is quite expensive, and experiments have been made with other products. Coal tar preparations have not been successful; the volatile oils evaporate and leave a brittle residuum which disintegrates and disappears. The essential requirement is for a preparation with a high enough melting point so that after placing, it remains hard, and retains for a fairly good length of time its quality as a waterproofing coat over the macadam and is not worn out or rolled and pushed aside under heavy traffic. This the engineers of the Department of the Interior seem to have accomplished quite successfully.

The writer is indebted to Armando Vivoni, superintendent of public works, and Enrique Ortega, assistant superintendent, for courtesies extended and information as to costs and other data used herein.

How Turbid Colorado River Water Was Made Fit to Drink

Purification and Other Features of the Plant at El Centro, Calif., Described—Information on Other Treatment Works

By Irving C. Harris
Of Cone & Harris, Consulting Engineers, Los Angeles, Calif.

THE great irrigation and power possibilities of the Colorado River have been much in the public mind for some years past. Los Angeles and many other cities in Southern California are now looking toward that stream as a possible source of municipal water supply. To those who have seen the turbid waters of this stream, carrying about one per cent by weight of sediment, this proposal brings up the question of its suitability for domestic purposes and the methods of treatment required to prepare it for such uses.

The underground structure and other conditions of water supply in the Colorado River delta region and the surrounding country are such that supplies of water for domestic purposes are obtainable, by diversion from surface streams or by development of underground waters, at but few places and in small amounts. As a consequence, most of the people of Imperial Valley and vicinity have had to depend upon the use of Colorado River water direct or from the irrigation ditches for their domestic water supply. This is true of the cities, including Calexico, Brawley, El Centro, Imperial and Westmoreland, and also of Yuma, Ariz. The methods of treatment of the water vary from the mere settling out of the most of the sediment in ponds to the complete sedimentation, filtration and chlorination processes used by the city of El Centro.

On the farms and in the cities where sand filtration is not used, the individual consumer uses some type of stoneware filter to clarify the domestic water. The cities of Westmoreland, Brawley and Imperial do not use sand filtration; hence, in these cities, the individual user provides his own filter. Brawley chlorinates the water from the settling basins; hence the water going to the mains is disinfected if not entirely clear.

El Centro, the seat of Imperial County, is a thriving progressive city of 6,000 to 7,000 people. Some years ago, the municipal water system was developed to a state that seemed adequate then, but the city's growth and the passage of time had left the city with an outgrown, depreciated and somewhat obsolete water system on its hands, with the consequent fire menace and accompanying high insurance rates. In the latter part of 1923 the city administration started a program of extensive betterments. A bond issue of $200,000 was voted and sold for the purpose. As completed, the water-works system is of a very high standard for a city of this size.

Water is conveyed from one of the canals of the Imperial Irrigation District to a series of settling reservoirs with an average depth of 9 ft., located in the outskirts of the city. The reservoirs were originally unlined, with embankments having an inside slope of about one to one, and with the bottom of each graded at a flat slope to a sump at the middle of one of the longer sides. Under the program of betterments just completed, the embankments have been faced with concrete.

The water flows first into one of two small interconnected reservoirs, with normal water level areas of 12,600 and 14,000 sq.ft. From the smaller basins, the water flows to six other interconnected reservoirs of about 140,000 sq.ft. aggregate normal water surface area. Any one of the eight reservoirs may be cut out for cleaning. From the last reservoir, the water flows by gravity, under normal operation, to two parallel 24 x 200-ft. filters having a capacity of over 5 m.g.d. under a normal 22.7 m.g.d. per acre rate. There is no chemical treatment except chlorination. A Blaisdell traveling washer is used. Satisfactory results are obtained with it alone but a judicious combination of the washer with back-washing is advantageous.

The filtered water flows to a dome-covered reinforced-concrete clear-water reservoir, 75 ft. in diameter and 14 ft. deep, from which the water is pumped to the mains and elevated tanks. The daily consumption

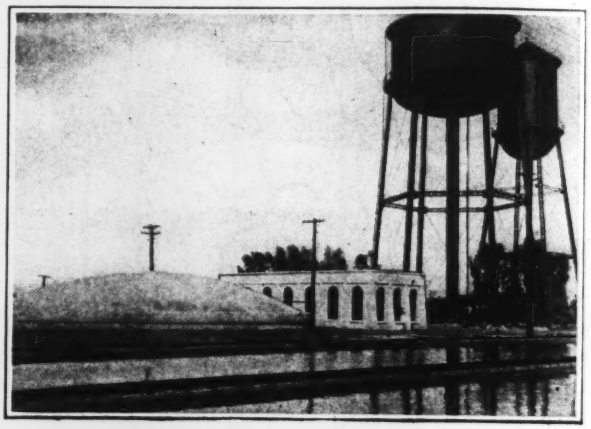


FIG. 1—WATER-SUPPLY WORKS OF EL CENTRO, CALIF. Filter bed in foreground, then covered clear water reservoir and pumping station. Old and new water tanks at right.

ranges from about 1 m.g.d. in winter to 2 m.g.d. in summer. At the end of the period of detention in the settling reservoirs, which ranges from five to ten days, the greater part of the silt has precipitated; but the water going into the filters is far from clear. The filter effluent is clear and nearly negative bacterially, but chlorination is applied, a Wallace-Tiernan apparatus being used. Periodic tests are made upon samples taken from the irrigation canal, various parts of the reservoirs and filters, and from the mains. Bacteria are always present in the irrigation ditch. Roughly, the sedimentation reservoirs remove about 90 per cent, the filters about 90 per cent of those left, and chlorination destroys the last remaining B. Coli. The methods of clarification and purification here described produce a satisfactory product. The principal improvement that might be desired, would be aeration to reduce taste sometimes present due to vegetable growths along the canals. The content of soluble salts varies according to the stage of the Colorado River, averaging 300 to 400 p.p.m.

The removal and final disposal of the silt from the bottoms of the reservoirs is a considerable item of expense. Gravity sluicing is impossible at El Centro on account of the flatness of the country and the lack of an outfall within nine miles. A 3-in. motor-driven sand pump and a 3-in. jetting pump, each mounted on a car

operating on industrial tracks, provide the means of removal from the basins. The water is drawn down in the reservoir to be cleaned; and the sand pump is lowered into position in the sump at the side of the reservoir by means of an overhead chain hoist, in order to reduce the suction lift. The sediment is of such consistency that it flows on a very flat grade to the sump. Any that does not flow readily is washed down by means of a hose and nozzle supplied with water by the jetting pump above mentioned. The discharge from the sand pump is piped to settling ponds, where it gradually dries out; after which it is added to the embankment. Several acres have been covered to a depth of 20 ft. or more; and the city has recently purchased ten acres of adjoining land to provide for future operations.

The location of the city of Imperial is such that it is necessary to use similar methods of disposing of silt. Brawley is only a short distance from New River, one of the channels cut by the Colorado River on its way to the Salton Sea; and the sediment is sluiced out of its concrete-lined sedimentation reservoirs by gravity, assisted by a jet of water, as at El Centro, through an outfall line discharging into New River. Calexico is on the banks of this same channel at the international boundary, and can use the same method of disposal.

Because the electric power supply comes a long distance and is subject to frequent interruptions—usually of from 1 to 15 minutes duration, but sometimes longer, with the possibility of an interruption of a day or two—it is necessary to provide reserve storage and power supply. Two elevated tanks, one recently installed,

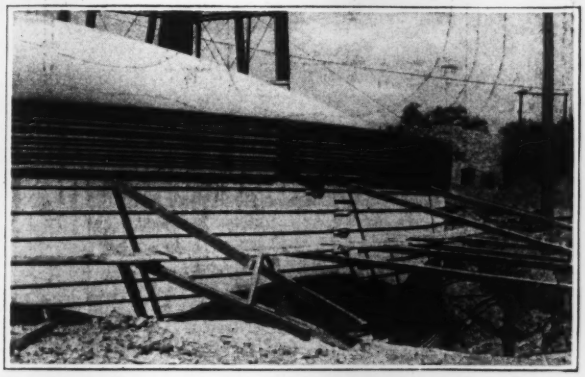


FIG. 2—CLEAR WATER RESERVOIR, SHOWING OUTSIDE REINFORCING RINGS

give a total storage of 0.35 m.g. at El. 70 to 102 above the ground and Sterling gasoline engines afford supplementary power. When it is necessary to have the water out of the irrigating canal for maintenance purposes sufficiently long to demand it, a booster pump between the reservoirs and the filters is used to compensate for the lowering water level in the settling reservoirs. At other times the flow is by gravity.

The filtered water reservoir is of a design which uses the Hewett system of reinforcing cylindrical structures carrying internal hydrostatic pressures. The abutment rings of the dome roof of this tank were placed on a suitable flange in accordance with the same method.

The new pumping plant consists of four units housed in a reinforced-concrete building, the floor of which is 10 ft. below ground level in order to place the pumps low enough to receive water by gravity and eliminate priming and air-leak troubles. Two of the units are of about 1,000-g.p.m. capacity and are electrically driven. The other two units are of about 2,000-g.p.m. capacity and are equipped with electric motors and Sterling engines direct-connected. The electric motors are controlled by an automatic switchboard; and any one pumping unit may be put under control of a float switch mounted on the new elevated tank.

Soil conditions are such that wrought iron has a very

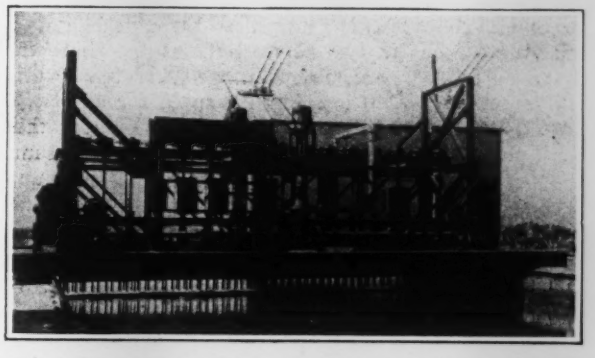


FIG. 3—NEW BLAISDELL TRAVELING FILTER WASHER
Washing nozzles are lifted above water and jets are spraying

short life; and the use of cast-iron pipe is necessary. All services are of lead pipe; and all are metered. Flat rates were in effect for a number of years; and when meters were put in, the usually noticeable reduction in the consumption of water was very apparent. The water rates have been 16c. per 1,000 gallons for the first 20,000 gal. with a minimum charge of $2, which covers the first 12,500 gal. used. All water used from 20,000 to 100,000 gal. is charged at 15c. and all in excess of 100,000 gal. at 14 cents.

The new pumping units require 1 kw.-hr. per 2,000 gal. pumped as an average for three months' operation. Based on the approximate average static head between the water levels in the filters and the elevated tanks, this indicates an average overall plant efficiency of 60 per cent.

The installation of the equipment at the water-works and the lining of the reservoirs were executed by the city's own forces under the direction of Robert H. McKibbin, superintendent of the water system. The other work was done by contract. Cone & Harris, consulting engineers, Los Angeles, were engineers for the design and construction of the improvements.

Constitutional Aid to Zoning in New Jersey

A constitutional amendment designed to meet New Jersey court decisions largely destructive of zoning in that state was passed for the first of the necessary two times by the legislature of 1926. If passed again in 1927 it will go to popular vote. It reads: "The Legislature may enact laws under which municipalities, other than counties, may adopt zoning ordinances limiting and restricting to specified districts, and regulating therein, buildings and structures, according to their construction, and the nature and extent of their use, and the exercise of such authority shall be deemed to be within the police power of the state." An amendment, subsequently considered inadequate, was passed by the 1925 legislature.

Large Screening Plant Handles Los Angeles Sewage

Installed Capacity Now 230 M.G.D. with Space Available for 190 M.G.D. Additional—Pneumatic Ejectors in Use

SEWAGE from the city of Los Angeles, Calif., which is discharged into the Pacific Ocean through the concrete outfall described in *Engineering News-Record*, Aug. 20, 1925, p. 292, is first passed through drum-type revolving screens in two plants built at the shore end of the outfall. The combined capacity of the screens now in service is 230 m.g.d., with space for additional units that will bring the capacity up to 420 m.g.d. The south plant has been in service since early in 1924 and the north plant began operations in March, 1925. As yet no report giving detailed figures on operation and on the disposal of screenings has been completed but the main features of installation and operation are reviewed in the following notes.

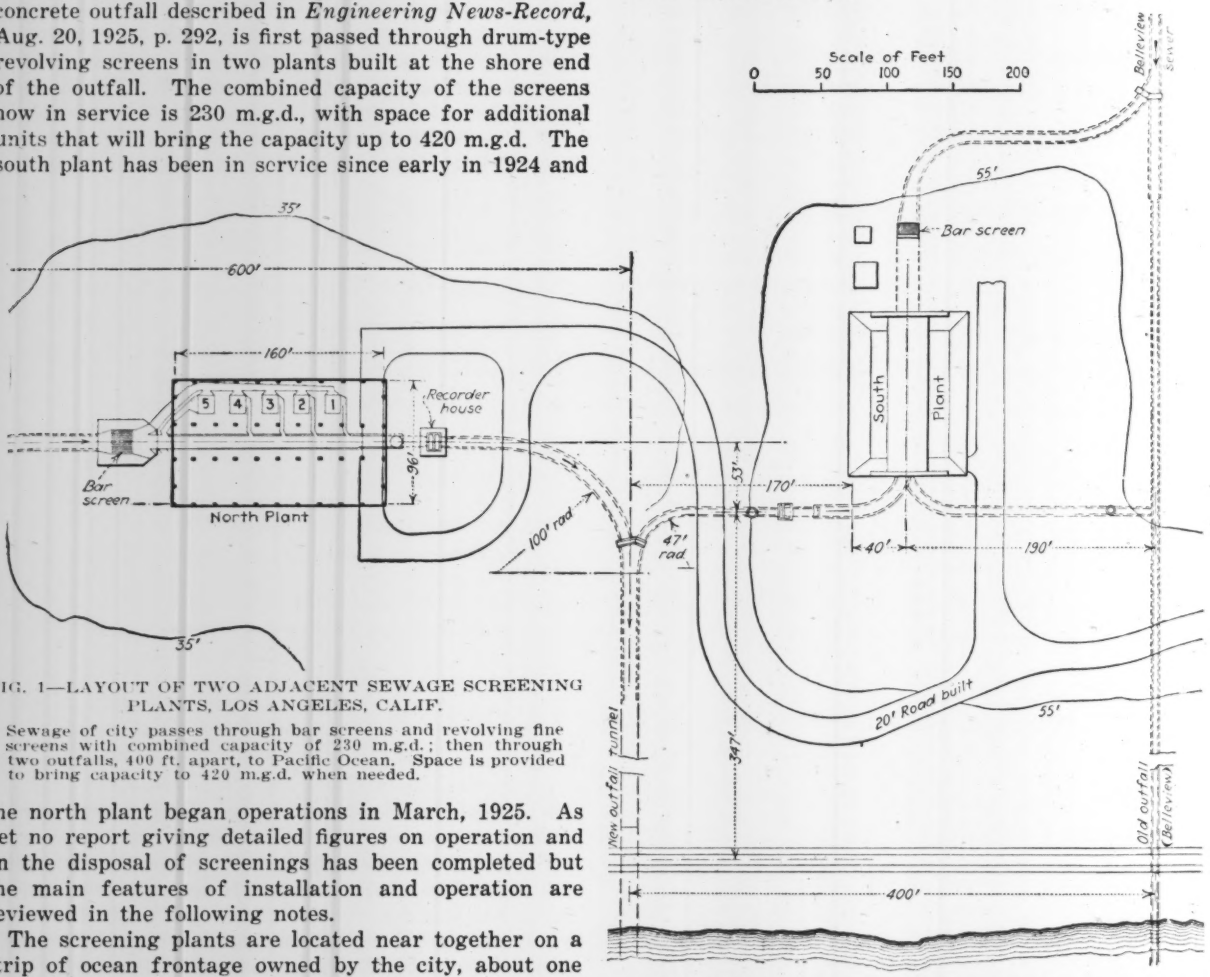


FIG. 1—LAYOUT OF TWO ADJACENT SEWAGE SCREENING PLANTS, LOS ANGELES, CALIF.

Sewage of city passes through bar screens and revolving fine screens with combined capacity of 230 m.g.d.; then through two outfalls, 400 ft. apart, to Pacific Ocean. Space is provided to bring capacity to 420 m.g.d. when needed.

The screening plants are located near together on a strip of ocean frontage owned by the city, about one mile long and one-quarter mile in width. The original intention was to develop power from the sewage discharged from the south plant with which to drive both screening plants. This would be possible because the terminus of the Belleview outfall sewer, the main source of supply of the south screening plant, was some 26 ft. above the sewage level in the north plant, which feature, together with the average quantity of flow, was then considered sufficient for all power needs. The idea of power development was abandoned before the south plant was installed and the only reason for making it separate from the north plant was that the city was urgently pressed for time in getting one of these plants into operation immediately in order to abate shore pollution.

Both plants are housed in structures of reinforced concrete, brick and stucco with steel roof trusses. Concrete roads connect the plants with the state highway. Careful attention has been given to laying out the grounds in an attractive manner. The plants are located about 500 ft. from the ocean and 1,000 ft. from

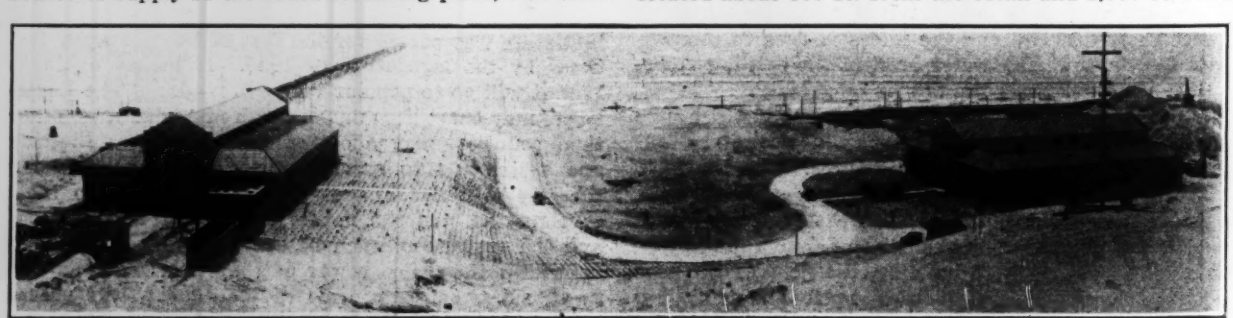


FIG. 2—GENERAL VIEW OF LOS ANGELES SEWAGE SCREENING PLANTS AND OLD OCEAN OUTFALL AT HYPERION

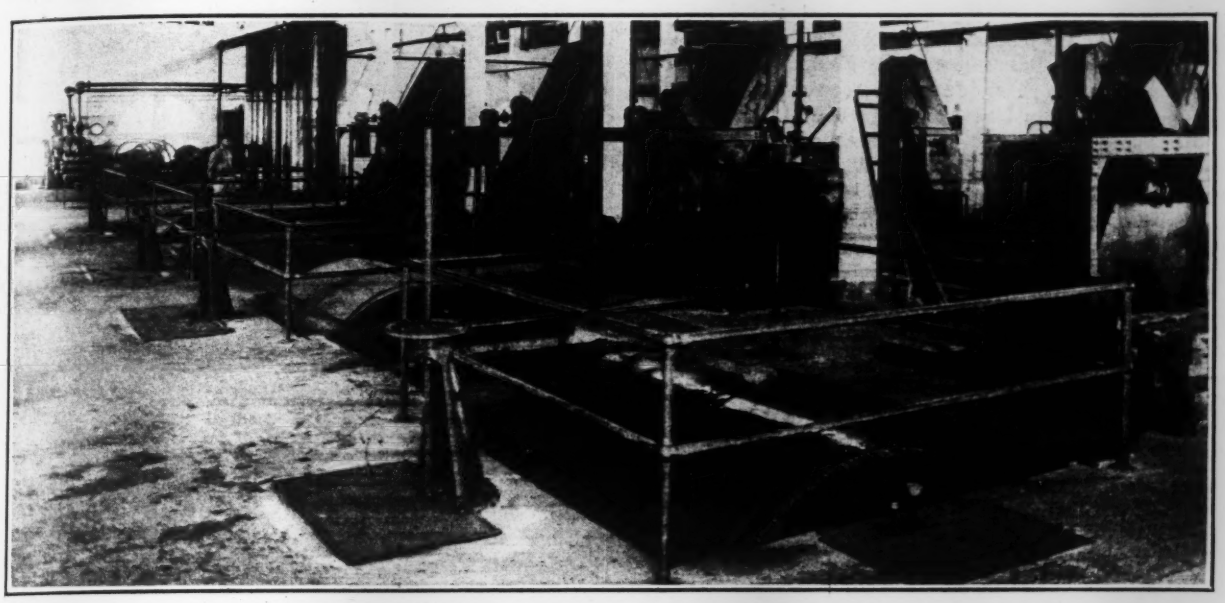


FIG. 3—SOUTH SEWAGE SCREENING PLANT OF LOS ANGELES, CALIF.
Eight 8x8-ft., 10-m.g.d., Dorrco revolving drum-type fine screens with eight elevators for lifting screenings to as many ejectors

the city limits of El Segundo from which the plant is separated by an intervening ridge of high sand dunes. The business center of this town is about one mile southeast of the plant.

South Plant—The building which houses the south plant is 91x126 ft. in plan, thus providing space for two bays in each of which six 8-ft. revolving drum screens can be installed. Eight of these screens with a capacity of 10 m.g.d. each have been installed and are now in service. Each screen is driven by a 5-hp. motor through suitable speed gear reductions and has a separate enclosed bucket elevator driven by a 1-hp. motor to elevate screenings into metal hoppers from which they are ejected by compressed air. The operations of the plant have been made automatic to such a degree that three men on the day shift and two men on each of the two night shifts are adequate to perform all necessary operations.

The Belleview outfall sewer is intercepted about 200 ft. south of this plant and sewage is first passed through inclined bar screens arranged conveniently for hand raking. The effluent from these bar screens enters a common double channel, thence through gates to the

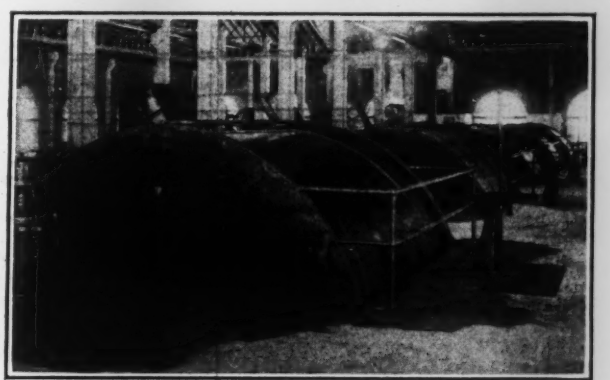
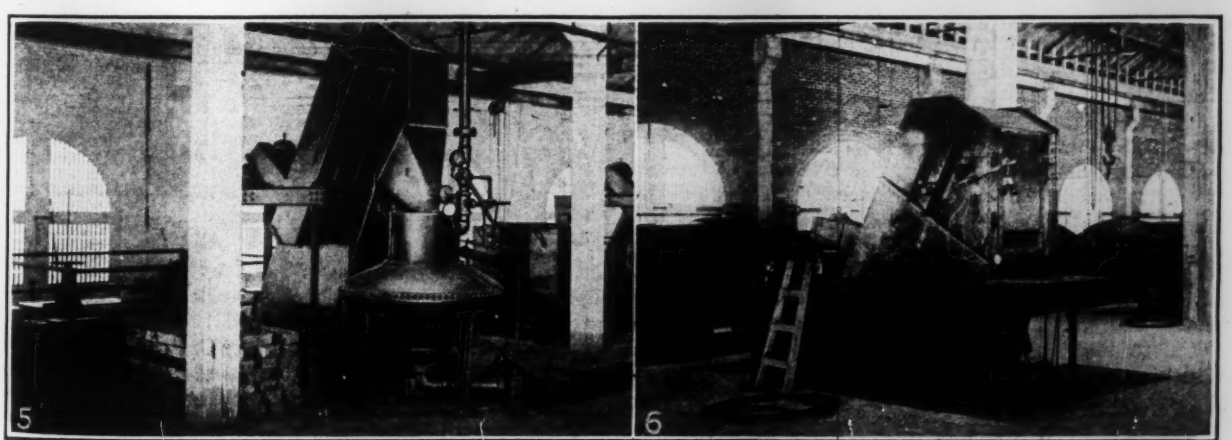


FIG. 4—ONE OF FIVE 14x12-FT., 30 M.G.D. DORRCO SEWAGE SCREENS AT NORTH PLANT, LOS ANGELES

drum screen chambers. The effluent from the drum screens passes through a 38-in. Venturi self-recording



FIGS. 5 AND 6—SCREENINGS ELEVATORS AND EJECTORS AT THE TWO LOS ANGELES SEWAGE SCREENING PLANTS

Fig. 5—South Plant: One of eight units. Screenings lifted and dumped in hopper from which they fall into the ejector and are piped to receiver. End of one of the screens at left.

Fig. 6—North Plant: One of five units. Hopper, only, projects above floor at this plant; ejector and both the air and sludge piping are below.

meter and thence to the main outfall about midway between the two plants.

North Plant—Bar screens are also placed ahead of the five screens in the north screening plant, which is housed in a 96x160-ft. building 500 ft. north of the south plant. Here the fine screens are to be in two rows of five screens each. One-half of this plant or one row of five screens is now in service. These screens are 14 ft. in diameter and 12 ft. long, each with a capacity of 30 m.g.d. The other five units will double the present capacity, making the north plant total 300 m.g.d.

Each screen is driven by a 40-hp. motor and is equipped with a screenings elevator driven by a 2-hp. motor and discharging into metal hoppers 3 ft. in diameter and 10 ft. deep from which the screenings are ejected by air pressure. This plant is operated by seven men in the day shift and two in each of the two night shifts. Later the labor for both plants may be combined.

The hydraulic problem in designing the north plant was complicated somewhat by the fluctuating sewage level in the 10½-ft. sewer supplying this plant, and by the necessity of conserving all available head for the ultimate discharge of the ocean outfall sewer. In order to get the desired efficiency in the drum screens the expedient of using screens of large diameter was adopted, setting the axis at the maximum discharge line of the sewer. The sewage is then purposely backed up in the influent channel to maintain an elevation desirable for efficient operation.

The routing of the sewage through the plant is apparent from the accompanying plan. The effluent channels are somewhat lower in elevation than the influent channel. En route to the outfall the sewage passes through a 54-in. Venturi recording meter.

During the year 1925 the average flow of sewage through the two plants was 83 m.g.d. and during this same period the average amount of screenings removed was 1,338 cu.ft. per day or 16 cu.ft. p.m.g. During this period the average cost for maintenance and operation was $105 per day or $1.26 per million gallons.

Sewage disposal at Los Angeles is under the general direction of John C. Shaw, city engineer. W. T. Knowlton is sanitary engineer.

Steel Arch Trusses for Barn

A STEEL hay-barn with rigid arch-truss framing was recently built on a Michigan farm. This novel type of farm structure was adopted because it provides a large interior space clear of the obstructions which occur in the ordinary type of timber barn construction. Fig. 1 is a view of the frame erected and ready for the steel sheathing; Fig. 2 shows the general structural design.

The barn, 36x72 ft. in plan, has five arched trusses of 36-ft. span, 34 ft. high and spaced 18 ft. c. to c. In the roof, the three middle trusses are connected by diagonal bracing; similar bracing is placed in the two end panels of each side wall; the two middle panels have doorways fitted with sliding steel doors, there are no end doors. Purlins and girts of steel channels are bolted to the trusses and carry the siding and roof sheathing of corrugated galvanized steel of copper-bearing grade.

The barn stands on a concrete basement 12 ft. high, which is used as a stable and stock barn. The steel superstructure was designed for a live load of 20 lb. per sq.ft. and a wind pressure of 20 lb. per sq.ft.

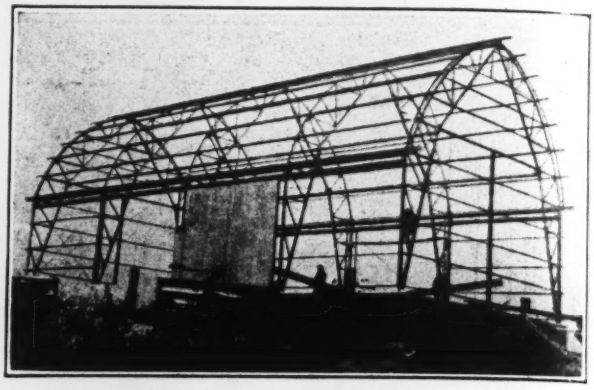


FIG. 1—HAY BARN WITH ARCH TRUSS FRAMING

Each truss was shipped in four sections, which were erected with the aid of a gin pole. Field connections at the crown and haunch joints of the trusses and all purlin and other attachments were made with bolts. All erection was done by the farm force, under direction of a foreman of the steel contractor.

This steel barn was designed and built in 1922 for

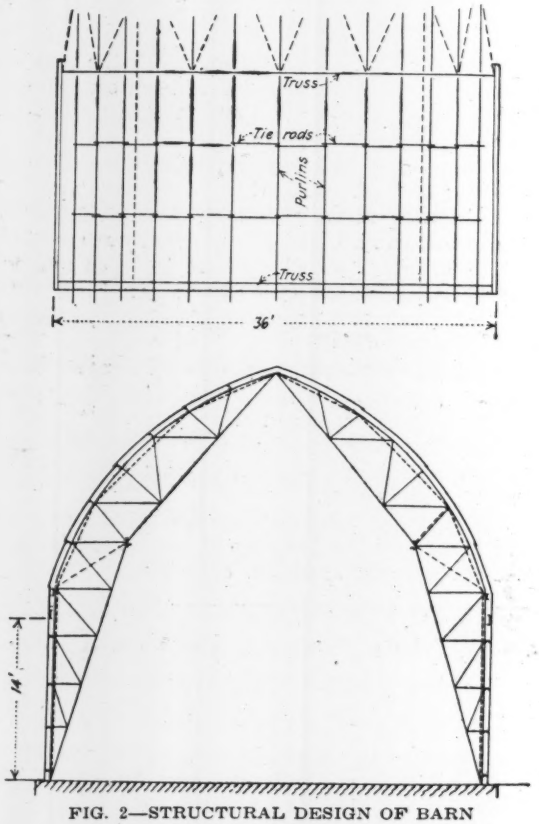


FIG. 2—STRUCTURAL DESIGN OF BARN

J. D. Cole, of Milliken, Mich., by the Continental Bridge Co., of Chicago, the steelwork being fabricated at its shops at Peotone, Ill., and shipped ready for erection. The company's engineer, C. S. Kayser, made the designs for this very unusual structure. For large barns which would require heavy timbers, the cost of the steel frame is said to compete closely with that of timber construction. The building is fireproof throughout, and is well grounded in case of being struck by lightning.

One of a Series of Articles on the Details of Design and Layout of Different Types of Industrial Buildings

Warehouse Embodies Latest Industrial Building Design

Cantilever Girder Framing for Driveway and Railroad Track—Sawtooth Roof Lights Top Floor Offices—Elevators, Conveyors and Spiral Chutes Handle Goods—Dock and Freight Tunnel

TYPICAL of modern steel-frame multi-story industrial buildings is the 13-story warehouse erected at Chicago in 1925-26 for Hibbard, Spencer, Bartlett & Co., wholesale hardware merchants. Since the entire building is occupied by the one firm, it has ltitle of the interior partition subdivision required in commercial warehouses, such as those at Duluth, Cincinnati and Chicago, described in *Engineering News-Record* of Feb. 21, July 24, and Dec. 11 and 25, 1924, pp. 324, 138, 942 and 1033. Fig. 1 is a view of the hardware company's building under construction, in December, 1925. Fig. 2 is a typical cross-section.

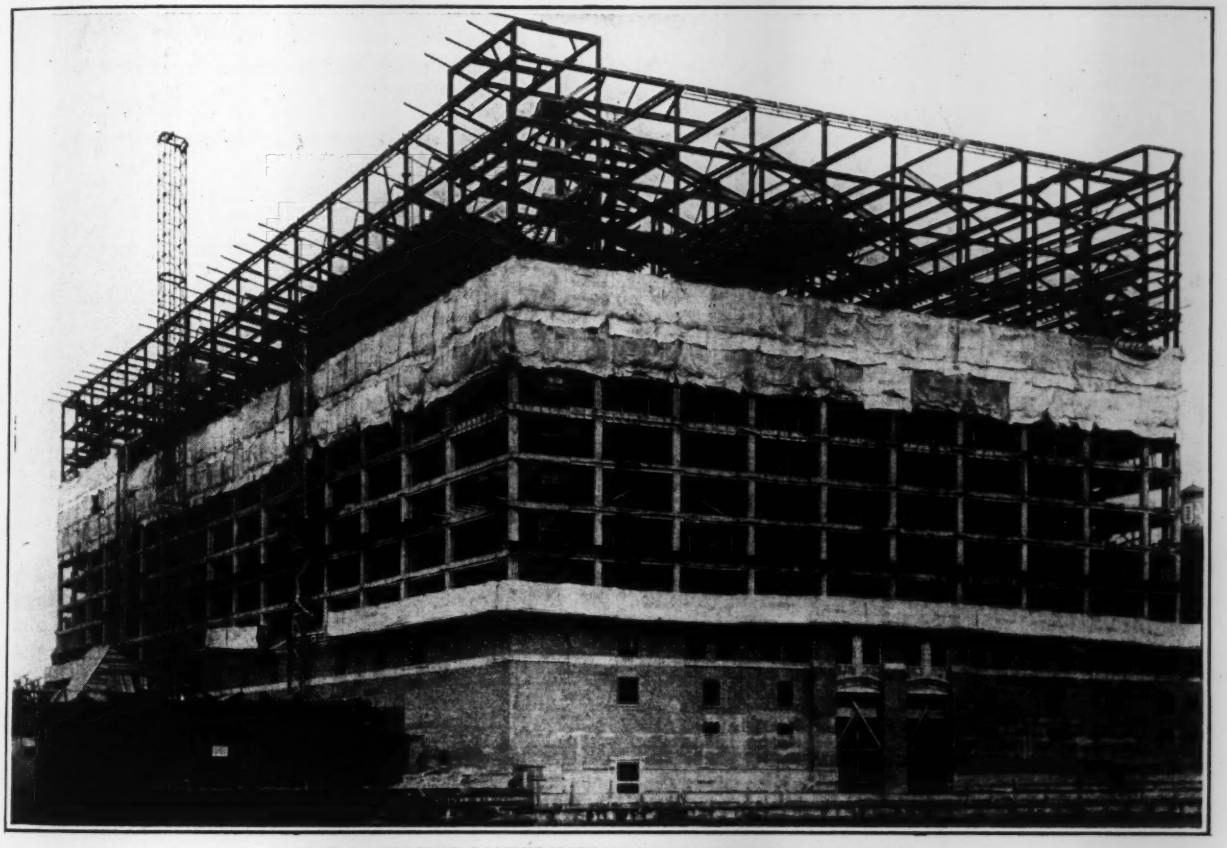


FIG. 1—WINTER CONSTRUCTION OF WAREHOUSE BUILDING
Note sawtooth roof for lighting offices on top or 13th floor. The upper canvas enclosure is for the floor concreting and the lower enclosure protects the bricklayers building the exterior walls.

A large clerical force is required for the hardware company's business, and an unusual feature of the new Chicago building is the location of offices, show rooms and light machinery on the top floors. General offices and open clerical spaces, together with toilet rooms and other facilities, occupy the whole of the 13th floor. On the 12th floor are show or sample rooms and also rooms for the ventilating fans and machinery and for the blowers of the pneumatic tube system which handles inter-department messages and letters. All the lower floors are for storage purposes, with packing and distributing facilities on the second floor. Materials are received and shipped on the first floor. The basement is utilized for heavy storage, and for receiving and shipping goods by the narrow-gage underground line of the Illinois Tunnel Co., a spur from which extends to the bottom of an elevator shaft in which the tunnel cars are handled to and from the first and second floors, a distance of about 70 ft. from tunnel track to second floor.

Certain special features may be noted: Heavy girders in the first floor framing to carry a railway track and a driveway, and in the second-floor framing to carry columns over the track and driveway; a sawtooth roof designed to give ample light to the offices on the top floor; the arrangement of elevators in sep-

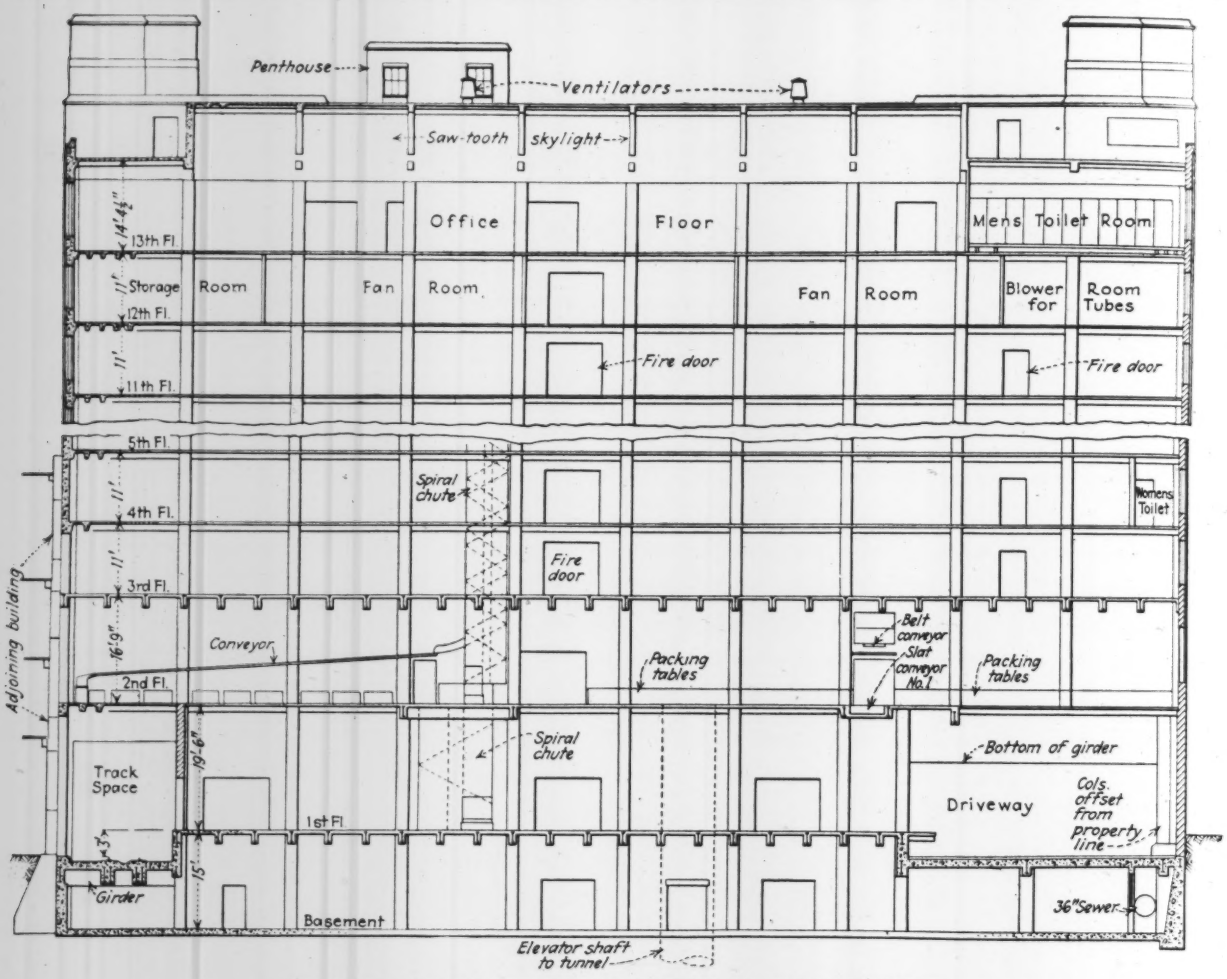


FIG. 2—TYPICAL CROSS-SECTION OF STEEL-FRAME WAREHOUSE

arate groups; the provision of vertical spiral chutes for freight, extending from the 11th down to the first floor; inclined and horizontal conveyors for handling goods on the first floor; elevator connection with an underground freight railroad; and the provision of facilities for receiving and shipping goods directly by railroad car, wagon and boat at the first floor.

General Description—This warehouse building is 172 ft. wide, fronting on North Water St., but as its rear is on the river bank, which is diagonal to the street, the two sides are 415 ft. and 327 ft. in length, with a rear wall 193 ft. long. The acute angle of the rear wall is cut off with a bevel, for convenience and appearance. Wood piles in clay and concrete piers sunk to rock are used for the foundations, the former supporting the footings for interior columns and the latter being placed along the two sides to insure stability in case of future deep foundations being sunk for adjacent buildings. At the river end is a concrete dock wall, on wood piles, but this does not carry any of the building load. The difficult foundation work was described in *Engineering News-Record* of Feb. 18, 1926, p. 281.

A basement 13 ft. deep below main floor level extends over the entire area of the building, and has a sub-basement 77x82 ft. for boilers, pumps and other machinery. The first story is 19 ft. 6 in. high, from floor to floor, to allow the passage of railway cars and the use of overhead conveying machinery. In the storage floors the height from floor to floor is 11 ft., but the top story (for offices) has a clear height of 12 ft. to the girders of the sawtooth roof.

Inside the first story and along the east wall (occupying the first bay) is a railroad track which enters diagonally through the north or street front and has a curve of 150-ft. radius inside the building. Along the west wall is a driveway or concourse 36 ft. wide for wagons and motor trucks. The concourse, having a clear headroom of 14 ft., is open to the building, but the track space is shut off by a wall between the first and second floors. This wall has doorways 12 ft. wide and 8 ft. high, spaced 20 ft. apart and equipped with steel rolling curtain doors.

The exterior is of red brick and terra-cotta, with steel-frame windows. On the inside, the brick walls and concrete ceilings and columns are not given any surface finish, except that the office portions are plastered. A transverse brick fire wall divides the building and has at each floor two openings fitted with automatic fire doors. Two wide doorways at the rear open at the level of the dock wall and provide for handling goods by barges or steamers. For convenience in shipping and unloading goods, the first floor is about 3 ft. 6 in. above the driveway (at street level) and 4 ft.

above the rails of the railroad track. Above the roof rises a 65-ft. tower 48½x22½ ft., in which are placed two house tanks and two sprinkler tanks, the latter being on a floor about 40 ft. above the roof level.

Typical Framing—In general the column spacing is 20 ft. longitudinally and 16 ft. 10 in. transversely, as shown by the framing plan, Fig. 3. The columns are of H-section, composed of a web plate and four angles, with cover plates on the angles. Wind bracing consists of gusset connections between the wall columns and spandrel girders. In the second floor and all upper floors, except the third, the steel floor framing consists of symmetrical lines of I-beams between the columns, carrying slab-and-joist concrete floors, there being no intermediate steel beams. In the 12th floor, however, some of the panels have closely spaced I-beams on account of extra loading due to fans and other machinery. Where double-girders and double-beams are used, they are provided with connecting plates across the flanges and separators between the webs.

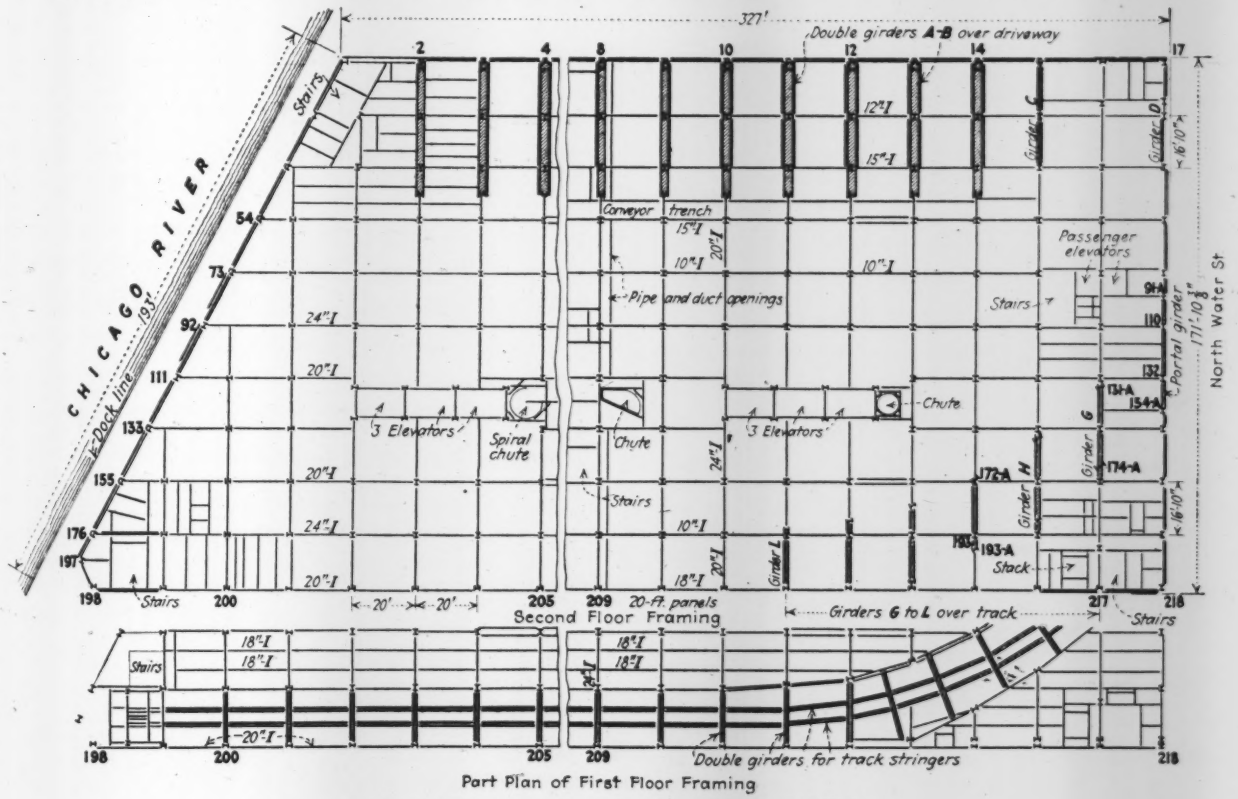


FIG. 3—STEEL FRAMING PLAN: SECOND FLOOR
Note girder construction over track and driveway. The smaller plan at bottom shows girder framing to carry railway track on first floor.

In the first and third floors, which are designed for heavy loading, the panels are subdivided by lines of I-beams running lengthwise of the building, and the floors are flat 4½-in. concrete slabs. In all cases, the concrete is carried down to encase the steel beams and girders. Live-loads are taken as 300 lb. for the first floor, 150 lb. for the second, 250 lb. for the third and 150 lb. for all upper floors, except 75 lb. for the 13th (office) floor. Variations in floor construction are shown in Fig. 4.

Girders in Floor Framing—Two modifications in the first floor framing are required for supporting the railroad track along the east side and the team or truck driveway along the west side. For the former, shown at the bottom of Fig. 3 and in detail in Fig. 5, double cross-girders have framed between them two lines of track stringers, each stringer composed of a pair of 24-in. I-beams embedded in concrete and carrying a concrete deck slab. As this track makes a curve inside the building, it was necessary at some points to introduce auxiliary columns, which do not extend above the first floor, to carry these diagonal or radial cross girders on the curve. For the driveway, three lines of longitudinal girders have transverse I-beams framed between them and carrying the deck slab. This arrangement is modified somewhat at the entrance.

In the second floor framing, there are a number of girder spans over the track and the driveway, as shown in the plan, Fig. 3, and in detail in Figs. 6 and 7. Since the track enters at an angle and then makes a curve it was necessary to omit several columns in the first story and to shift others from their symmetrical arrangement in order to give ample clearance for the cars. In seven bays, beginning with the front wall, girders are required over the track, with varying arrangements of columns, as shown by the plan and elevations. Thus, the portal girder in the north wall, Fig. 6, is 7 ft. deep and 39 ft. long, with its ends supported on columns 37 ft. c. to c., while on it are seated two upper story columns 16 ft. 10 in. c. to c. In the next two bays, the girders have both ends cantilevered beyond the supports to carry upper story columns, while a third column is seated at the middle of the girder. One of these girders is shown in Fig. 7.

Other girders are cantilevered only at one end, and the girders nearest the tangent track are not cantilevered. All these are double-web girders 60½ in. deep.

Over the driveway, the second floor is carried mainly by double 7-ft. girders 43 ft. 7 in. long, which rest on columns spaced 39 ft. 8 in. c. to c., the girders being cantilevered about 26 in. on the outer side. This cantilever arrangement is due to the fact that all foundations are kept within the property line, and the wall columns up to the first story are thus set back from the line. The second story cantilever girders carry the upper wall columns on this property line. Each girder carries

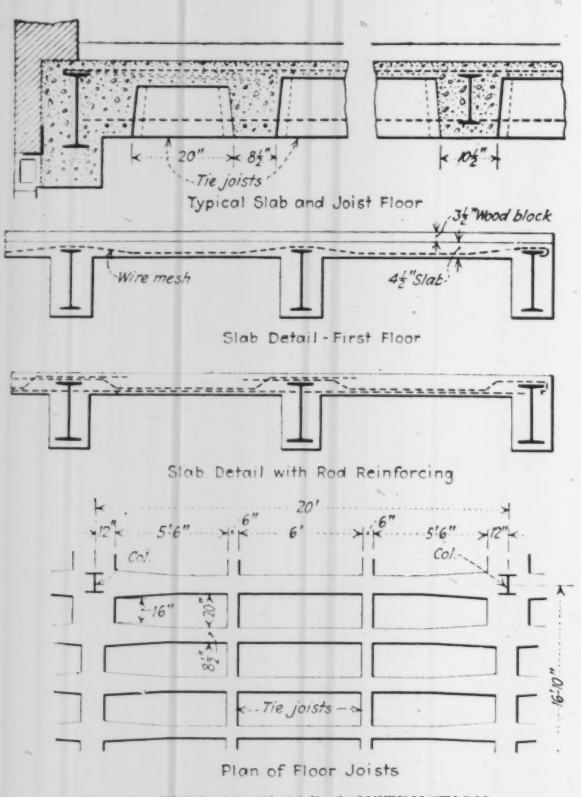


FIG. 4—TYPICAL FLOOR CONSTRUCTION

not only the wall column but also two intermediate columns. All these are double girders 83½ in. deep, Fig. 7.

Floors and Floor Finish—On the first floor a paving of 3-in. creosoted wood block is used, the concrete slab being first coated with a bituminous composition with which the blocks are also grouted. For convenience in loading and unloading goods, this floor is 4 ft. above the level of the railroad track and 3½ ft. above that of the street and driveway. Along the latter, the floor is extended about 4 ft. as a cantilever, forming a platform against which to back wagons and trucks, while the space beneath this platform can be swept and flushed as part of the roadway. A 4½-in. asphalt paving on a 12-in. concrete slab is used for the driveway.

Removable concrete slabs in the first floor cover panels 12½x8½ ft., each panel having three slabs 4 ft. 1½ in. wide. The 4-in. concrete slab is covered with the 3-in. wood block paving used on the floor and is in an angle-iron frame 7 in. high. In each slab are two recesses for ring bolts used in handling, the recesses being formed by square cast-iron boxes covered normally with checker plates held by brass screws. These slabs are to provide occasional opening for the purpose of replacements or additions to the mechanical equipment of boiler rooms.

Tracks of 24-in. gage for the tunnel cars are laid on this floor, having light rails riveted to steel ties which

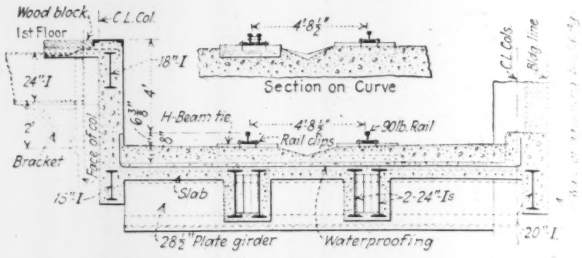


FIG. 5—TRACK AND TRACK DECK IN WAREHOUSE

are embedded in a strip of concrete paving flush with the wood-block paving. For the deck of the standard-gage track, the concrete is given a float finish and the surface is sloped to form a drain between the rails, so that the floor can be swept and flushed. Embedded in the concrete over each stringer are short pieces of 6-in. H-beams, to which the 90-lb. rails are secured by clips on bolts through the H-beam flanges. On the curve, a 90-lb. guard rail is placed inside the inner rail, giving a flangeway of 4⅞ in.

All the upper floors are of the ribbed slab type, mainly with a 3-in. slab and 12-in. joists, giving a total beam depth of 15 in., as in Fig. 4. These joists are generally 8½ in. wide at the bottom, with a clear spacing of 18 in. or 26½ in c. to c. No ceilings are used, but the concrete is given a smooth finish. Metal pans are used as floor forms being removed with the supporting falsework after construction. At certain points the floors have openings or slots 14 in. wide, for the passage of pipe and duct risers; these slots are generally along the side of a panel and double girders are used in this part of the framing.

In the basement, the second floor and up to the

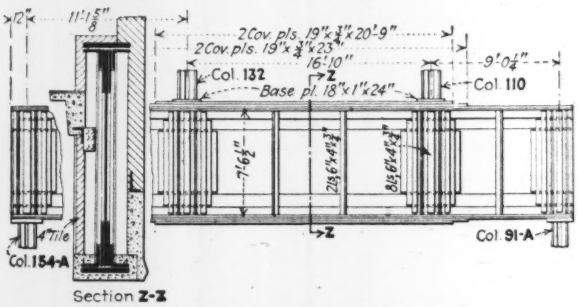


FIG. 6—PORTAL GIRDER OVER TRACK ENTRANCE

12th floor, the cement-floor is given a hard and dense surface finish to resist wear due to trucking. When the finished floor is dry it is given three slush coatings of a hardening mixture; the first coat is 2 parts water to 1 part concentrated solution; the second 1 to 1, and the third 1 water to 2 solution. For the 13th or office floor, a 4½-in. fill of lean concrete is laid on the structural concrete slab and covered with 1-in. concrete flooring. In the main part of the space this flooring is covered with linoleum, but wood floors are used in the offices. For the toilet rooms on the 13th floor, a

false floor is provided about 12 in. above the normal level to form a pipe space.

Roof Construction—An unusual arrangement is the location of the offices and clerical space on the top floor as already noted, partly on account of better light and ventilation. In order to provide good daylighting, the greater part of the roof is of the sawtooth type. This roof, Fig. 8, has an I-beam framing which is carried

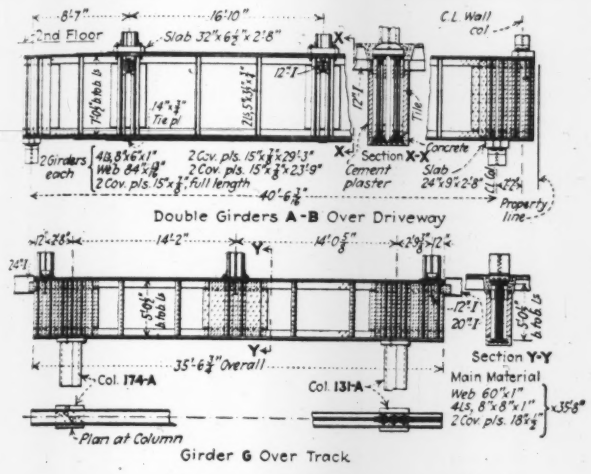


FIG. 7—CANTILEVER GIRDERS IN SECOND FLOOR FRAMING

by transverse I-beams in the standard bays of 16 ft. 10 in. and by plate girders in bays of 33 ft. 8 in. where interior columns are omitted to allow more freedom in office arrangements.

The north faces, with a slope of 1 on 8, have steel sash with wire-glass; the south slopes of 1 on 1½ have 2½-in. ribbed concrete slabs covered with insulation and a composition roofing. On the inside, a furred ceiling of plaster on metal lath is carried up under the flatter slopes, and sprinkler pipes are placed behind this ceiling, as shown. The sash is hinged and is arranged in two rows; in the upper section the sash is operated mechanically for ventilation purposes; in the lower it is operated by hand for convenience in washing. Additional ventilation is provided by exhaust ventilators along the ridgers. In the end and side bays, the roof is flat, with a 2-in. concrete slab on I-beam framing and covered with composition roofing.

Mechanical-Handling Equipment—Eight electric elevators are installed; two for passengers and six 3-ton freight elevators, arranged in two separate banks of three each. For the tunnel service, an oval shaft 14 ft. 6 in. x 8 ft. 4 in. extends from the first floor down to a spur of the tunnel system already mentioned, so that the tunnel cars can be switched to the elevator and delivered directly into the building. There they are moved by hand on tracks laid in the floor, as described. Ashes from the boiler room can be spouted to cars in the tunnel.

For convenience and speed in handling goods for shipment, three spiral chutes are provided, extending from the 11th down to the second floor, and from there to the shipping floor. In this way, goods from the various stock floors are delivered to the second floor to be packed, being distributed from the chutes to the packing tables by long inclined belt conveyors. From these tables, a slat conveyor traveling in a trench in the floor conveys the packages to a continuation of the spiral chutes, by which they are delivered to the shipping floor.

Ventilation and Heating—Mechanical ventilation is provided in the basement and the first, second and thirteenth stories supplementing natural ventilation, each of these stories having a separate system of ducts for fresh air supply and exhaust. For the 13th story, two fresh-air fans, each equipped with an air washer, provide washed air to private offices and staff space. The mechanical plant has independent systems of fresh air supply and exhaust so as to provide suitable working conditions for the attendants.

Heating is by direct radiation on a vacuum system, except for the shipping space, track and teaming concourse in the first story. Approximately half of the radiators in each story are equipped with temperature control and alternate with others having hand valves. Temperature control is by switches located at convenient points, but office radiators in the top story are automatically controlled by thermostats in each office. Coal for the heating boilers is brought into the building in drop-bottom railroad cars and dumped into a track hopper over a 200-ton coal bin.

Fire Protection—The building is equipped throughout with sprinkler systems connected to roof tanks and fire pump, wet sprinkler systems being installed in all heated spaces and dry sprinkler systems in unheated spaces. The fire pump takes water from a city main and discharges into a header, from which wet and dry systems of sprinklers are supplied by an underground

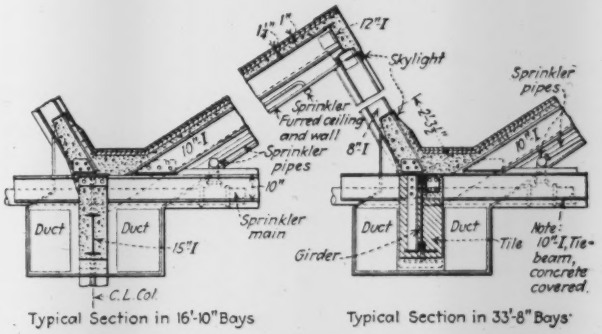


FIG. 8—SAWTOOTH ROOF

main. A 6-in. fire boat connection at the dock and two 4-in. steam fire-engine connections to the header at the fire-pump afford additional protection. Fire hose in each story is attached to wet systems of sprinkler piping.

Electric Power and Light—For the basement and most of the stock floors there is one 100-watt lighting unit in each bay; for the 13th floor, one 500-watt unit; for the 3rd, 4th and 5th floors, two 60-watt units, and four 75-watt units for each bay in the sample room section on the 12th floor. An indirect fixture with mirror-back reflectors is used in the main office areas on the 13th floor and a small office on the second floor, for the purpose of giving diffused light and reducing eye strain. Power requirements total 898 hp., as follows: elevators, 370 hp.; ventilating fans, 265 hp.; fire pumps, 150 hp.; conveyors, air-washers, pneumatic blowers, refrigerating apparatus and miscellaneous purposes, 113 hp. To supply the needs of telephones and various signal systems, as well as local desk lights, a complete duct system is provided under the floor of

the 13th story, with standpipes led up under the desks. A service connection to electric mains in North Water St., is led to a five-panel switchboard in the building.

Construction Work—Rapid progress and cold-weather concreting were special features made necessary by the demolition of the company's older structure to make way for the city's double-deck driveway along the south bank of the river. Excavated material was dumped through chutes into cars of the freight tunnel system already mentioned. Foundation work was commenced in August; the steel roof was completed Dec. 5, and the 13th floor was poured Dec. 24. Handling and storage of construction material was complicated by the fact that the site had the river at one end, a four-story building on one side and a one-story building on the other side. Half of the latter was rented for the handling and storage of cement, aggregate and reinforcing steel.

Erection of the structural steel, about 9,000 tons, was done with five steel guyed derricks having 100-ft. masts and booms. A railroad track occupies the street, but the structural steel was delivered at a railroad yard on the other side of the river and trucked to the building. Much other material was handled by trucks for convenience, but most of the reinforcing steel, brick and mechanical equipment was delivered directly on cars.

A 1-yd. concrete mixer served a 260-ft. steel tower from which the concrete was spouted into place or to hoppers from which ½-yd. buggies were loaded. Form lumber, steel-pan floor forms and reinforcing steel were handled on two skid hoists and two boom hoists on the outside. Inside the building were six double-platform elevators for carrying brick. As most of the superstructure concreting was done during cold weather, six boilers were installed for heating the water and aggregate. The stone and sand conveyors were enclosed to conserve heat and exclude snow.

During November and December, two or three floors at a time were entirely enclosed by tarpaulins, while large numbers of coke-burning salamanders were installed on these floors. Similar enclosures on the lower floors enabled the bricklaying on the exterior walls to proceed (see Fig. 1). With these arrangements, a story was concreted every four days, with about 64,000 sq.ft. of floor area. The same progress was made with the exterior walls. Forms were left in place for two or three weeks and the steel-pan floor forms were removed with the falsework. The construction force averaged 700 men for the steel erection, concrete, brick and miscellaneous work.

Engineers and Contractors—The architectural, structural and mechanical designs of the building were prepared by Graham, Anderson, Probst & White, architects, who also supervised the construction. The general contractor was the Henry Ericsson Co., whose superintendent was Martin Larson. The steel frame was erected by the Oscar Daniels Co. This warehouse, represents a cost of approximately $4,000,000.

Reforestation in New York State

The spring planting program of the Conservation Commission of the State of New York calls for planting 17 million forest trees in more than 2,000 separate plantations. The planting is being carried out on the basis of 1,000 trees to the acre, representing the reforestation of 17,000 acres.

Tallest Concrete Chimney on American Continent

Stack of Reinforced Concrete for Zinc Roasting Plant in Western Canada Rises to 400 Ft. Above Foundations

THE NEW chimney for the Wedge Roaster Plant of the Consolidated Mining & Smelting Co. of Canada, Ltd., at Tadanac (Trail), British Columbia, is built of reinforced concrete and is the tallest of its kind on the American continent. Its purpose is to furnish adequate draft and to discharge the gases at such a height that they will have a chance to diffuse and be less injurious to plant and animal life. It is 21 ft. in diameter inside the lining at the top and 400 ft. high above the foundation slab.

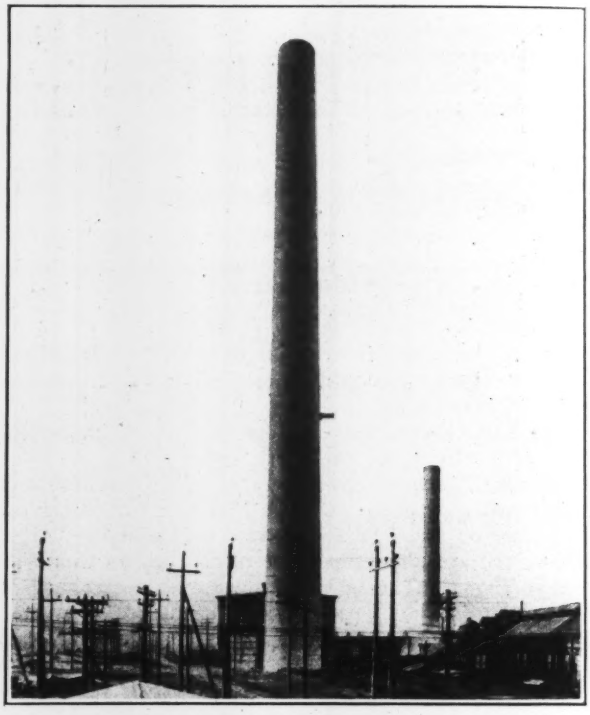


FIG. 2—COMPLETED CHIMNEY—400 FT. HIGH

The chimney is designed to fulfill the following requirements:

Capacity—650,000 cu.ft. per minute
Elevation of base of stack—1,600 ft. above sea level
Gases to pass through a Cottrell dust collector
Minimum temperature of gases—280 deg. F.
Maximum temperature of gases—450 deg. F.
Average temperature of gases—340 deg. F.
Maximum temperature of outside air—100 deg. F.
Analysis of gases 2 per cent SO_2—trace SO_3
Draft at base of stack—1¼ in. water column

Field work on the chimney began 12 days after the signing of the contract, and the entire job, including lining, was completed in 170 working days.

The foundation, containing about 900 cu.yd. of concrete, was placed by continuous pouring in 6 days, using three 8-hour shifts. It rests on sand and gravel and is octagonal in shape, with an inscribed diameter of 66 ft. and a thickness of 9 ft. It is designed to support the weight of the shaft, the lining and a wind load on the

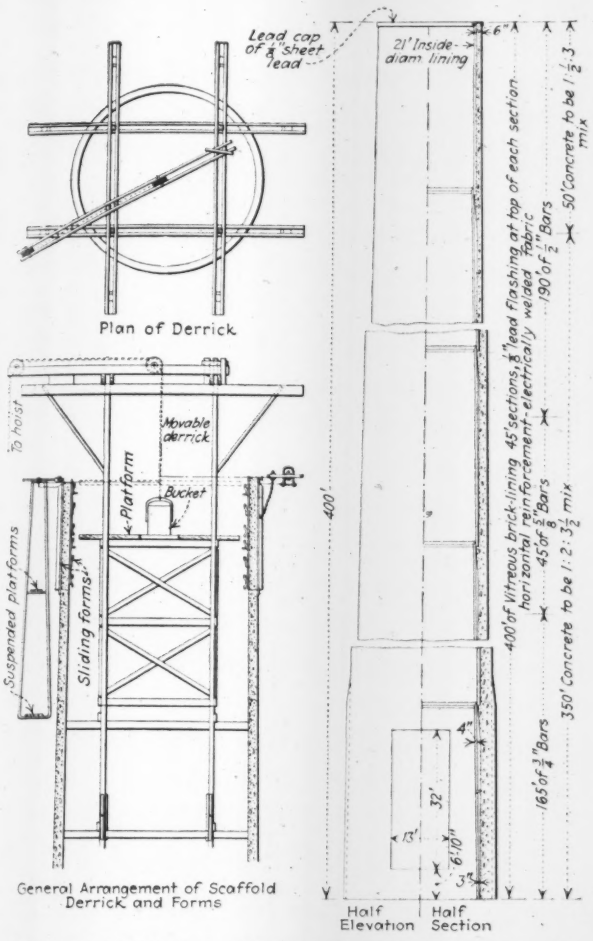


FIG. 2—ELEVATION OF CHIMNEY AND CONSTRUCTION DETAILS

chimney produced by wind blowing at 100 miles per hour.

The column was built with the contractor's patented all-steel forms in sections 7 ft. 6 in. high. Wooden scaffolding was carried on the inside of the chimney to the full height, supporting the cathead, which was used for supporting the forms and the hoisting and distributing of the materials. Details of the equipment

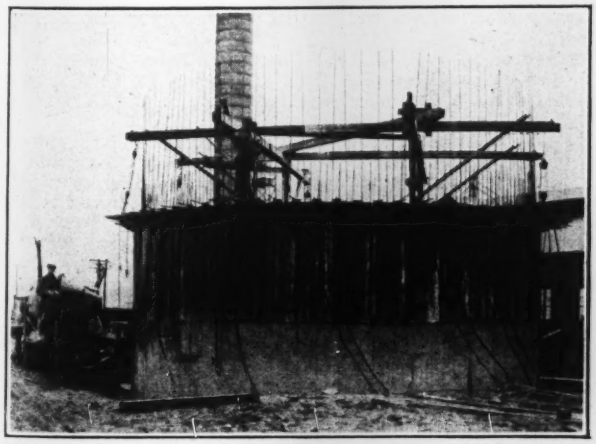


FIG. 3—FIRST SECTION POURED WITH FORMS SET FOR SECOND SECTION

are given in the accompanying halftones and drawings, and need no further explanation. The wall thickness of the column at the top is 6 in., at the base 2 ft. 6 in. and 3 ft. 3 in. on the flue opening side. The flue opening is 13 ft. wide x 32 ft. high, at an elevation of about 6 ft. 10 in. above the top of the foundation. Additional concrete reinforcing was provided at this opening, by increasing the thickness of the walls 9 in. on the outside for a width of about 36 ft. and for a height of about 45 ft. A section through the lower 45 ft. of the chimney, therefore, is not a true circle on the outside, but is a true circle on the inside. The section through the upper 355 ft. of the chimney is a true circle on both outside and inside.

Vertical reinforcing bars are provided to take up tension due to wind load and vertical temperature stresses, whereas electric welded fabric is provided to take up tension due to horizontal temperature stresses.

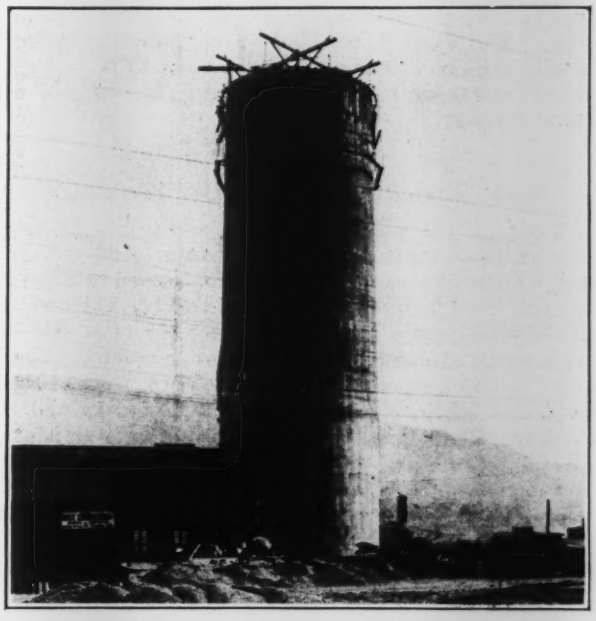


FIG. 4—CONCRETE POURED TO 105 FT. SHOWING LOCATION OF MIXER AND HOIST

Additional reinforcing bars are provided at the sides and at top and bottom of the flue opening. Several steel rings completely encircling the chimney are placed above and below the openings for stiffening purposes, as well as to form a reinforced-concrete beam at the top and bottom.

An acid-resisting lining of vitreous brick 4 in. thick was built into the chimney for the entire height, in sections—supported on corbels on the inside of the exterior shell of concrete. At the top of each section a lead flashing is provided and at the top of the chimney a lead cap to cover the top section of the lining, as well as the top wall of the main shaft. The lining when finished was painted with silicate of soda.

A cleanout door is provided at the base of the stack to give entrance into the chimney. An outside ladder was installed on the chimney from the top of the flue opening to the top of the chimney, and an observation platform placed at an elevation of 160 ft. above the foundation for taking samples of flue gases. The chimney is provided with a lightning rod consisting of ten copper points connected by a circuit cable, and grounded by

means of two down cables. The upper 50 ft. of the lightning rod system is lead covered.

The concrete mix for the major portion of the shaft was one part portland cement, two parts clean sharp sand and three and one-half parts gravel. The mix in the upper 50 ft. of the shaft was 1:1½:3, while the mix for the foundation was 1:2½:4½. All materials conformed to the requirements of the standard specifications of the joint committee for reinforced concrete of the American Society of Civil Engineers. The fine aggregate was screened sand, 0–No. 4 mesh. The coarse aggregate for the column was screened gravel ⅝ in. to 1¼ in. The coarse aggregate for the foundation was screened gravel ¾ in. to 3 in. A slump of 6 to 7 in. was maintained. Twenty-eight-day tests on 6x12-in. cylinders showed an average strength of about 2,600 lb. per square inch.

The chimney was designed and built by The Rust Engineering Co. of Pittsburgh, Pa., under the supervision of Eric Plagwit, manager of the Chimney Division. Another chimney of the same height and 25 ft. in diameter is now being built for the Lead Department of the same company.

Early Strength of Lime-Mortar Brickwork

Tests of the strength of brickwork laid in lime mortar, made by P. C. Cunnick, director of the laboratories of Rock Island Arsenal, were reported in a paper recently read before the Building Officials Conference at Columbus, Ohio, by J. S. Elwell. The tests showed high early strength of lime-mortar masonry. Tests were made on small wall specimens 8 in. thick, 16 in. long, and 36 in. high, at ages of 1 to 7 days and at 28 days. The laying was done with ¾-in. mortar joints, all joints full, by the arsenal bricklayers, and was considered to represent good average practice. The loads required to produce a compressive deformation of 1/64 in., 1/32 in., and 1/16 in. per foot of height were measured. For 1/32-in. deformation they ranged from 70 lb. per sq.in. at 1 day to 180 lb. at 28 days. These figures were obtained with 1:3 mortar made of (1) hydrated lime and (2) lime putty aged 14 days; lime putty aged only 3 days gave considerably lower strength in the 1 to 7-day tests, but at 28 days was about as strong as the other mortars. Tests of shearing strength were made on three bricks bonded together with two ordinary mortar joints and tested vertically with the two outer bricks supported 3½ in. apart and the load applied to the middle brick. The author computes from the results that at the age of 1 day a single brick surrounded by mortar on two sides and two ends would have a resistance to displacement of 250 lb., and that at 28 days it would require a uniform pressure of 72.8 lb. per square inch on the exposed face of a standard brick in a 4-in. wall to force it loose. Mr. Elwell concludes that under the specification of the building code committee of the U. S. Department of Commerce (in "Minimum Requirements for Masonry Wall Construction"), which allows a loading of 90 lb. per sq.in. on 1:3 lime mortar and 50 per cent more when stresses are computed, a brick party wall carrying residential floor loads suitably distributed by joist construction could safely be carried up to a height of 10 stories and would afford a factor of safety of 6 on the 28-day strength of the brickwork.

Bond and Anchorage of Bars in Reinforced-Concrete Beams

Unreliability of the Bond Formula—Anchorage Effected by Excess Bond and by Mechanical Means—Bond and Cracks

IN reinforced-concrete design, the important factor of bond between the steel and the concrete is one which has received considerable attention, both in theoretical analysis and practical test, but as to which there is still doubt and uncertainty. Bond and anchorage of the bars in reinforced-concrete beams, as two aspects of this factor in design, were discussed in a paper presented before the Western Society of Engineers by T. D. Mylrea, assistant professor of structural engineering at the University of Illinois, and some extracts from this paper are given below.

Bond and Cracks—In a beam containing a definite amount of reinforcement, straight and full length, the position of the neutral axis remains fixed at a position somewhat below mid-depth until cracking occurs. Moreover, before cracking, the bond is probably perfect, and the steel therefore takes a constant proportion of the total tensile stress at all points along the beam. This proportion is about 45 per cent for beams with percentages of steel of from about ½ per cent to 2 per cent. In such cases the steel stress varies directly with the ordinate to moment diagram, although accounting for only part of the total tension. If the value of V in the bond formula is reduced in the same proportion, the formula will give the correct distribution of bond in the beam before cracking.

When a beam is loaded heavily enough to produce design stresses in steel and concrete, it is cracked throughout a considerable portion of its length; and cracks greatly modify the distribution of bond. Wherever the concrete in a beam has cracked, the steel stress is at least as high as its computed value, neglecting the tension taken by the concrete between the top of any crack and the neutral axis, which rarely amounts to more than a very small percentage of the total tension. Between cracks the steel tension varies considerably, of course, from a maximum at the crack to a value that at early loads may be less than half that amount approximately midway between cracks. At high loads the stress midway between cracks approaches the computed value, and then the steel stress at cracks away from the point of maximum moment may actually be higher than computed, due to the failure of bond between cracks.

In a simple beam, the magnitude of the stress at the crack nearest the support, and hence the load carried, may be limited in certain cases by the tension that can be developed in the steel by bond between that crack and the end of the bar. One of the most extensive investigations on bond is reported in Bulletin 71 (Dec. 8, 1913) of the Engineering Experiment Station, University of Illinois, by Duff A. Abrams. Many of these results, however, were anticipated in a paper by William Fry Scott presented to the American Society of Civil Engineers in 1910, which paper marks a turning away from some of the older ideas regarding bond.

Tests indicate that the actual average bond stress developed in a simple beam at first end slip, but not the nominal value determined by the bond formula, including the overhang, is in the neighborhood of 200 lb. per sq.in. on round bars in 1:2:4 concrete about eight months old. The usual specified limit of 80 lb. for such bars thus represents a factor of safety of about 2½ in concrete of this description. But we are not at all certain of the stress at the last crack, which may be higher than computed. Thus we are in the uncomfortable position of knowing that the bond formula does not give the true bond and yet having no means of finding out what the true bond is. There is some comfort in the thought that the bond value determined by the usual formula from test beams failing in bond, with a suitable factor of safety applied, will give the same factor of safety when used in designing similar beams by the same formula, even though the actual bond stress is not known in either case. It should be borne in mind, however, that we are

then dealing solely with factors of safety, in spite of the familiar assumption that designs are based on working stresses rather than on ultimate strengths; and there is no valid reason for assuming that such values will be obtained in beams varying very widely in shape from the test beams.

Since failure by diagonal tension occurred in the beams with large overhang, it seems reasonable to suppose that the slip over the support was more than at the end, and that a tension of some magnitude existed there. Therefore, the movement of the bar just inside the support would be larger at the beginning of end slip than where end slip was first noted in the beams without overhang. This would allow the end cracks to widen, with the resulting diagonal tension failure. Thus, slip of bar may not only result in bond failure, but may be the primary cause of other forms of failure.

It appears that the maximum bond stress developed, as computed from the maximum load carried by a short time specimen, is unsafe as a basis for determining working stresses, since the first end slip marks the beginning of the end.

Shortened Bars—If the reinforcement in a beam consists of several parallel bars, and if for economy some are cut off where no longer needed to resist moment, serious disturbances in bond stress may be expected. The cut off bars must develop a steel stress varying from zero to a maximum in the same distance that a much smaller difference of stress is developed in bars not cut off. Hooking the ends of the stopped off bar will not help the condition unless proper precautions are taken, since hooks tend to concentrate stresses in a region which is already in tension. thus inviting cracks, with a marked tendency to split the beam.

In beams where bars are bent up at an angle to resist shear, conditions are more favorable, especially if the bends are of long radius. If the bends are sharp, they have practically the same effect as hooks. For uniform bond strength in continuous beams with a single concentrated load in the middle of each panel, the distance from the column to the points where bars are bent down should be the same as the distance from the midspan of the beam to the points of bending up of bars. The length of bar in bond thus being the same for the same stress, the down bends will be called upon to furnish the same degree of anchorage as the up bends.

It is a common thing to see designs in which the bars resisting negative moment are bent down close to the support. for the purpose of resisting shear. While this may be quite permissible from the moment diagram, it is usually bad practice from the standpoint of bond, since the bend must furnish full anchorage and may split the beam.

Anchorage—While the anchorage of bars is an important consideration, which may be effected with varying success in different ways, perhaps the simplest method is to extend the bar far enough to develop it by bond.

Mechanical anchorages of various kinds have often been used when the bond was deficient. Nuts and washers on the ends of bars are reported to have been tried years ago by Thaddeus Hyatt, with unsatisfactory results. In another series of tests, a rather unique anchorage consisted of a plate with holes in it applied to each end of the beam, the reinforcement projecting through the holes and being bent back against the plate. It seems probable that the diagonal tension failure which always followed was due to slight end slip which this type of anchorage did not prevent. Tests of bars anchored in cylinders by means of nuts and washers show that "enormous pressures may be transmitted by concrete under these anchorages." None of the specimens were reinforced to prevent bursting, and in all cases failure was by splitting of the concrete blocks. The conclusion in bulletin 71 is that "The use of washers or bearing plates of ample area and stiffness which are rigidly attached to the reinforcing bar will accomplish much in increasing the usefulness of this form of anchorage."

Bends and Hooks—The right angle bend has always been a favorite form of anchorage in this country. In Germany the bend of 135 deg. is common; in France and England, the "fishtail" bend originated by Hennebique has been popular. Considére introduced the curved hook. Present practice in all these countries is becoming strongly in favor of this hook, usually with an opening larger than the 5d clear opening recommended by Considére. The Joint Committee, in its report of 1924, recommends a hook whose diameter is 8d center to center.

It is noteworthy that in all the types of mechanical anchorage mentioned, failure occurred by splitting of the specimen. When washers were used, their flexure was undoubtedly responsible; and for maximum efficiency they should be very rigid, or else reinforcement against bursting should be provided. Fishtails are liable to be flexible, while all forms of hooks and bends exert a severe splitting force because of their shape. The tendency of round bars to split the concrete evidently has a marked influence on the value of bends and hooks. This tendency is more severe where the mass of concrete to be split is small. If it is desired to reinforce against bursting by means of a spiral around the hook, the stress in the spiral must be kept low enough to prevent incipient splitting, say not over 5,000 lb. per square inch.

Conclusions—The following summary gives some of the more important points brought out in this discussion: (1) Bond is induced only by a difference in stress at two points in a reinforcing bar. (2) Before a beam cracks the actual bond is everywhere much less thas the computed bond. (3) After a beam cracks the actual bond may be much higher than the computed bond, even in the uncracked region. (4) First end slip of a bar measures the ultimate long-time load capacity of a simple beam. (5) The ordinary bond formula is unreliable in beams in which bars are cut off. (6) The bond formula is unreliable for negative reinforcing of continuous beams. (7) The bond formula is erroneous for beams in which the reinforcement is inclined with reference to the compression face. (8) In such beams anchorage is essential. (9) The extension of a bar may serve to anchor it. (10) Nuts and washers, properly spiralled, should make good anchors. (11) Bent or hooked bars tend to split the concrete. (12) Right-angle bends exert severe concentrated pressures and splitting stresses on concrete, and are liable to break off if the steel is brittle. (13) Where the mass of concrete to be split is small, as in the web of a beam, it is unwise to increase allowable bond on bars simply because they are hooked. Destructive secondary effect may follow. (14) Semi-circular hooks should not be of too large opening. (15) The splitting tendency of semi-circular hooks may be easily reinforced against, and such hooks may form good anchorage.

Low Leakage on 42-In. Submarine Pipe

Final test made recently by the city of San Francisco on the 42-in. flexible cast-iron pipe across Newark Slough showed a leakage of only 9.7 gal. in 24 hr. under a water pressure of 170 lb. per sq.in. This leakage was almost entirely accounted for at the bolted flange connections, at the two ends, which were put on the pipe for the test, indicating that the flexible pipe was practically "bottletight." The specified allowable leakage was 28½ gal. per hr. The Newark Slough crossing includes a 404.6-ft. length of subaqueous pipe in the approach to the Bay crossing of the Hetch Hetchy aqueduct which is just being completed. The work on the main crossing was described in *Engineering News-Record*, March 18, 1926, p. 434. A previous test on the Newark Slough crossing showed a leakage of 60 gal. per hr. An air-pressure test showed this leakage to be localized at one joint and this joint was then calked by drilling and tapping holes from the inside through which lead pellets were forced into the lead ring with the highly satisfactory result noted above. The main Bay crossing, 2,750 ft. long, has not yet been given the hydrostatic test because the submarine trench in which the pipe is laid has not as yet been completely backfilled. It has, however, been subjected to an air-pressure test of 50 lb. per sq.in. and with the recalking of one joint, done as at Newark Slough, the city officials are satisfied that the line will prove tight within the limits of the specifications. It will therefore be put in service initially without the hydrostatic test which will be made after the backfilling has been completed.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Narrow-Gage Railways

Sir—I was very much interested in the article in your issue of May 13, 1926, p. 787, "Engineering Fifty Years Ago, Narrow-Gage Railways."

During 1877-78, I was chief engineer of the Pittsburgh Southern R.R. in southwestern Pennsylvania, Pittsburgh-Washington, Pa., and 1879-80 chief engineer of the Pittsburgh and Western R.R., Pittsburgh-New Castle, Pa. These were narrow-gage lines, 3 feet. The first section built was from Castle Shannon to Finleyville, 12.6 miles. M. D. Hays, president of the Pittsburgh Southern R.R., died only a few months ago at the advanced age of 80 years and more. This 12.6 miles section contained grades of 3 per cent, with maximum curvature of 36 deg., with no compensation. The culverts were 2-in. plank. Trestles of timber, generally oak. The length or distance from Castle Shannon to Little Washington was about 40 miles. Rails were 30 lb. per yard.

Among the rolling stock of the Pittsburgh-Southern R.R. was a passenger car which took the first prize at the Centennial of 1876.

The article quoted from *Engineering News* of May 27, 1876, contains one typographical error: The Parker and Kansas City road in Pennsylvania should read: The Parker City and Kane Railroad. This line in the northern part of the state is now owned by the Baltimore and Ohio R.R.

Some figures from my notes on the cost of constructing the 12.6-mile section from Castle Shannon to Finleyville may be of interest. Earth excavation cost 16¼ cents, loose rock excavation 26¼ cents, solid rock excavation 44¼ cents per cubic yard, and earth was placed in embankments at 12 cents per cubic yard. Lumber for trestles and water tanks cost $25 per 1,000 f.b.m. and ties cost 30 cents. Track laying over the entire section cost $2,336, and the total cost of the 12.6 miles was $35,046, or a little over $2,700 a mile.

Buffalo, N. Y. EMILE LOW.
May 20, 1926.

Confusion of British Units in Railroad Work

Sir—To an engineer trained from boyhood in the confused jigsaw of British units there are pleasure and envy to be experienced in reading *Engineering News-Record* articles, with the stark simplicity of their units. We use, to begin with, different scales for horizontal and vertical measurements, on a railroad profile. The center line is measured in miles, chains and links, but heights in feet and hundredths. When the track is laid its length is measured and recorded in yards, but the property line fences alongside are recorded in chains. Clearing is measured in acres, but stone paving in square yards. Timber is purchased at per 100 ft. superficial, one foot super equaling a square foot an inch thick, but the same timber, when fixed, is recorded in cubic feet.

Radii of curves in siding turn-outs are shown on blueprints in chains, but in the crossing tables, leads, switches and clearances are given in feet and inches.

The most consistent units used are those of volume and weight. For all volumes except of timber we use the cubic yard. For all weights, we use the ton (2,240 lb.) with decimals, though material purchased by weight is invoiced to us in tons, hundredweight, quarters and pounds.

Thus a necessary part of an engineer's equipment is a set of conversion tables, which are constantly in use. My rodman carries a 66-ft. tape divided in yards and decimals on one side and in feet and inches on the other side; a 100-ft. tape divided in feet; a 5-chain band divided in links; and a staff divided in feet and hundredths.

Yet such is the force of custom that errors arising out of this confusion do not occur. The human mind works accurately even under such restrictions.

One imagines the reason for the persistence of these antediluvian curios to be the well-known inertia of Crown services. In his youth, each engineer curses the imbroglio of inches, feet, links, yards, and miles; grows used to it; and by the time he reaches a sufficiently "senior" stage is too interested to care one way or the other or to initiate the fight the abolition of inch, link and mile would involve.

May, 1926. BRITISH COLONIAL ENGINEER.

Two Early Deep Cellar Buildings With Caisson Foundations

Sir—Referring to the interesting article by C. S. Proctor and the letter by J. V. Davies, in your issues of April 15, p. 598, and April 29, p. 703, allow me to recall the fact that the first deep cellar in New York was the Commercial Cable Building, between Broad and New Sts., constructed in 1896-7, floor 16 ft. under water, and the second was the Mutual Life Building, three floors below water (32 ft.), the latter described in *Engineering News*, March 28, 1901. In each of these we erected the steel buildings on interior and exterior caissons before excavating for the basement floors. I designed the caissons for each of these buildings.

New York, T. KENNARD THOMSON.
May 3, 1926.

"Educational Engineering"

Sir—I have been very much interested in the occasional new entries to the evergrowing list of "engineers" to which attention is called by *Engineering News-Record.*

This calls attention to a new brand of "engineering" that the city of Denver can boast and does. I refer to the "Educational Engineer," now a prominent fixture of our public school system here.

This educational engineer picks up the instruments of the profession with true engineering instinct and gives us a round or two of definitions as to just what educational engineering really is, right at the start. These are interesting. We have them reported in the City Club Chronicle some time back.

The most important principle of this branch of engineering we learn is "factors of error." We know that this was the basic principle of our educational hodge podge but we just wonder if it is really engineering that the boy has in mind and question if he should not have branded his stuff "educational doctoring." With factors of error as a first principle, the cementeries would bear mute but convincing witness of the correctness of the nomenclature, for errors and doctoring just naturally associate themselves in one's mind together with cemeteries. Or, if educational doctoring does not have the proper penetration value as a name, perhaps educational barrister would satisfy, in which case the jails and penitentiaries would justify the connection, for, as everyone knows, the errors of the legal profession have languished in jail from time immemorial.

Our educational engineer continues that educational engineering is a problem of leisure. There! brother, that spills the beans. Engineering and leisure just will not get along together, not any better than fire and water. One or the other may survive a contact but naturally they do not go together. Financial reward and ease, so long as men find deep satisfaction and reward in changing visions into realities will remain as today for other than the engineer and men will dream and plan and build as men have gone down to the sea in ships and there find their motif of life. Young men will grow grey at engineering and leave it late in life to seek financial return as have many of our builders of today. The material rewards of engineering are few and small by the usual standards.

As for educational engineering what engineer is there who does not have thoughts of the possibility of applying the straight line methods of engineering to the teaching of his boys and girls and those about him? What engineer can look at the mess and muddle of aged women and ambitionless men who largely compose our secondary school personnel and not wonder what just a little engineering would do to the results of public instruction?

The possibilities are there but never in the world will they be developed on the basis of "factors of error" or "leisure" and until the engineering profession accepts its duty in branding these fakers for what they are will progress toward legitimate rewards for good service be made.

Denver, Colo., HALSEY BENSTER,
May 20, 1926. Mechanical Engineer.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Educators Meet to Discuss Co-operative Instruction

To Meet at Cincinnati to Study Plans for Instruction in Engineering Architecture and Commerce

An association recently formed by American colleges and universities giving co-operative instruction in engineering, commerce, architecture, and other subjects will hold its first annual meeting June 14 and 15 at the University of Cincinnati, where the co-operative system was originated by Dean Herman Schneider twenty years ago.

Under the co-operative plan the students spend alternate periods at the university and at work in industry. While one student is in school his alternate is receiving practical training in some factory or office, and vice versa. In this way both the school and the shop are always fully manned. The theory learned in the classroom is thus applied in industry, and the problems which arise in industry are brought to the classroom.

Co-operative courses have been established in many colleges, both in the United States and in foreign countries. Among the American institutions now offering such courses are the Municipal University of Akron, Ohio; Antioch College, Yellow Springs, Ohio; the University of Detroit; Drexel Institute, Philadelphia; Georgia School of Technology, Atlanta; University of Louisiana; Marquette University, Milwaukee; Massachusetts Institute of Technology; Newark Technical School, Newark, N. J.; University of North Carolina; Northeastern University, Boston; University of Pittsburgh; Southern Methodist University, Dallas, Texas; University of Texas, and the University of Cincinnati.

Practically all types of manufacturing and construction enterprises have been used successfully in the training of co-operative students during their outside work period. Transportation and commercial organizations have proved equally useful for the same purpose, and, more recently, co-operative relations have been established between the colleges and those industries in which art is a factor, such as jewelry, ceramic, and textile works.

Some firms employing co-operative students are the American Steel and Wire Co., American Rolling Mill Co., Baldwin Locomotive Works, Central of Georgia Railway, Columbia Gas and Electric Co., the Ferro Concrete Co., General Electric Co., New York Central Railway, Pennsylvania Railroad, and the Worthington Pump and Machinery Corporation.

At the coming session at Cincinnati a program will be presented dealing with various phases of educational work in college and industry and with the co-operation between the two.

Engineering Fifty Years Ago

From *Engineering News*, June, 1876

London Transit

RAPID transit has been further extended in London by the completion and opening for public traffic, on April 5, of the East London Railway, which is another of those gigantic underground enterprises for which the metropolis of England is so distinguished. The most remarkable feature of this new work is the fact that a considerable portion of the line is built under water. The tunnel extends southeasterly from the Liverpool St. station of the Great Eastern Railway, passing directly under the warehouses and water basin of the London docks, thence under the embankment, under and across the Thames River, to the New Cross station of the Southeastern Railway, thus connecting all the roads named, and also the London and Brighton and South London lines. At Shadwell and Whitechapel, magnificent stations, each 250 ft. in length, have been erected. The total cost of this new line, which is a little less than six miles in length, has been £3,000,000 or $16,000,000. That portion of the line under the Thames passes through the old Thames tunnel, built by the celebrated engineer, M. I. Brunel. This work was commenced in 1824, and opened for foot passengers in 1843, but never proved of much value to the public until brought into use several years ago as a railway tunnel.

Stevens Leads for President of Civil Engineers

Canvass of the first ballot for "official nominees" for officers of the American Society of Civil Engineers, made June 1, gives the following results: For president, John F. Stevens, 1,394, and Anson Marston, 1,165; for vice-president, Zone II, J. C. Hoyt, 248, Zone III, A. E. Morgan, 124, B. L. Brown, 80, A. Marston, 33; for directors, District 1, (two to be elected) G. J. Ray, 152, G. B. Lucas, 139, J. F. Sanborn, 28, Aubrey Weymouth, 18; District 4, F. O. Dufour, 143; District 11, A. C. Dennis, 172; District 14, C. M. Buck, 81, D. A. MacCrea, 17; District 15, J. H. Brillhart, 89, E. N. Noyes, 25.

Progress on Regional Plan of New York City

Representatives of Many Communities Hear Report on Regional Plan of New York and Environs

A hundred New York, Connecticut and New Jersey communities were represented at the meeting held in New York City on May 25, called by the Committee on Regional Plan of New York and Its Environs. Philadelphia, also engaged in regional planning studies, had several representatives present. Besides a general review of progress on the work of the New York committee, by Thomas Adams, general director, a summary of planning and zoning laws passed by the present session of the New York Legislature was presented by Edward M. Bassett, counsel to the committee. Reclamation of the Hackensack Meadows, in New Jersey, was the subject of a talk by J. Spencer Smith, president of the New Jersey Board of Commerce and Navigation and acting chairman of the New York Regional Plan Council. The board has been authorized to make a study of Hackensack Meadows reclamation possibilities.

Mr. Adams stated that his committee fully realized that it could not go beyond submitting the outlines of a comprehensive regional plan and leaving it entirely at the option of the 400 communities within the area to work as nearly to it as they see fit. This plan will be based on detailed studies of growth, character, and distribution of population and industries; railways, highways and waterways and corresponding means of passenger and freight transportation; park and other public recreational facilities; and zoning. Specialists in engineering, architecture, law and sociology are at work and the results of their studies will appear in 8 to 10 volumes, one of which will comprise a general summary.

Col. Samuel P. Wetherill, president of the Philadelphia Regional Plan Commission, remarked near the close of the meeting that he would take back with him as a three-word summary of what he had just heard, "popularize engineering intention."

Allegheny River Work Approved

The Chief of Engineers, U. S. Army, has approved the plan for improvements in the Allegheny River at an estimated cost of $1,534,000. The work includes the completion of locks and dams Nos. 4 and 5 and their appurtenances, thus extending slack water up to Nicholson's Island, 36 miles above Pittsburgh. Congressional requirements that unreasonable bridge obstructions in the Allegheny River be removed before any improvements start, are now being completed.

WASHINGTON NOTES

APPROPRIATIONS totalling $550,000 have been asked to carry out the provisions of the recently enacted air commerce act. Of the amount it is proposed to expend $300,000 in the installation, operation and maintenance of additional lighted airways. The additional $250,000 is for administrative expenses. In addition, the Post Office Department is to transfer $425,000 to the Department of Commerce for operation and maintenance of postal airways.

AUTHORITY to employ consulting engineers on reclamation work without civil service requirements and at rates of compensation not to exceed $50 per day, traveling expenses and $6 per day in lieu of subsistence, has passed the Senate and is recommended by the Irrigation and Reclamation Committee of the House of Representatives.

Under a recent ruling by the Comptroller General consulting engineers so employed cannot be paid in excess of $20.83 per day. Experienced engineers cannot be secured under that limitation.

The legislation is necessary as the Bureau of Reclamation is in immediate need of consulting advice on the following structures: The Echo Dam of the Salt Lake Basin project, Utah; the Gibson Dam of the Sun River project, Montana; the Stony Gorge Dam of the Orland project, California; the Owyhee Dam of the Owyhee project, Oregon-Idaho; the Thief Valley Dam of the Baker project, Oregon; and a dam connected with the Spanish Springs division of the Newlands project, Nevada.

SETTLERS on the North Platte reclamation project on May 27 hanged in effigy Secretary Work of the Interior department and Commissioner Mead of the Reclamation bureau. Many in Washington believe that this action will contribute more support for the policy of the reclamation bureau than nearly anything else that could have happened. It will focus attention on a project where delinquency has been most flagrant. No charges have been paid for three years. The irrigation district apparently was about to forget its obligation to the government. Dr. Mead explained, however, that no requirements were being made of settlers on the North Platte project that were not being applied generally. All superintendents have orders to require payment of one year's charges before water for irrigation is delivered. If payment cannot be made in cash, provision is made for the acceptance of promissory notes with a crop mortgage. In cases where, in the opinion of the superintendent, it is not possible for the resident water user to make cash payment or to execute notes with crop mortgages without rendering it impossible for him to carry on his farming operations and support his family, water is to be delivered notwithstanding the delinquency provided the user gives his unsecured personal note payable Jan. 1, 1927. Despite the leniency of these terms it is declared that there has been general refusal on the North Platte project to sign anything.

Those in Congress opposed to reclamation have seized on this instance to urge that the government retire from reclamation. Farm organizations also are insistent that all charges be paid, since excusing obligations to those on government projects constitutes unfair competition to private-enterprise farmers. Efforts to explain to the President the action of their constituents were made by some of the Nebraska legislators but it is understood that he is in full sympathy with the course being pursued by the Bureau of Reclamation.

After the hanging-in-effigy incident the authorities received definite promises that the North Platte irrigation district would assume full responsibility for operating and maintenance charges from July to January, during which time a liability district would be formed. The Secretary of Interior thereupon ordered that water be turned on. Thus the incident has resulted in the very commitment which the local interests have been holding up.

SENATOR REED, of Pennsylvania, is continuing his attack on federal aid for highways. He is emphasizing the point that such appropriations are, in fact, subsidies to the states. "The arguments we have been hearing set forth with such eloquence about the President's executive order show that the question of state rights is not always neglected, but when it comes to getting money out of the federal treasury then it is 'the Constitution be hanged' and the balance of power established by the Constitution is ignored."

Senator Reed's fight, however, promises to be no more successful than that of Don Quixote against the windmill. Senator Reed and a few other eastern Senators on May 26 tried to prevent the bill coming before the Senate for discussion. This made it necessary to move to take up the bill. The result of that roll call shows how overwhelming is the sentiment in the Senate for federal aid. There were only twelve votes against the motion.

As this is written, the prospects all are that the highway bill which authorizes the appropriation of $165,000,000 for highways over a period of two years will pass.

THE Chief of Engineers, in a letter to the Secretary of War, states that the Board of Engineers for Rivers and Harbors recommends a survey of the Yazoo base by the United States, with a view to developing a comprehensive plan for the control of its floods, at an estimated cost of $250,000; provided that local interests contribute in advance of the work 50 per cent of this estimated cost; and provided further that in the event that the survey can be completed and suitable plans prepared for less amount that one-half the sum thus saved shall be returned to the local interests. This action was taken at the request of the Committee on Commerce of the United States Senate for a reconsideration of a similar recommendation made to the 67th Congress. In the earlier recommendation the Board suggested that local interests contribute 80 per cent of the cost.

Operation of Buses by Railroads Subject of Investigation

The Interstate Commerce Commission, in order to inform itself of the legality and propriety of arrangements under which motor buses and trucks are operated by or in competition with railroads, has decided to enter upon an investigation of the subject. It has ordered, therefore,

"That the commission, upon its own motion, enter upon an investigation into and concerning the general question of the operation of motor buses and motor trucks by or in connection or competition with common carriers subject to the interstate commerce act, including the legality and propriety of the arrangements under which such motor buses and trucks are operated by or in connection with carriers subject to the act; also including the rates, fares, charges, etc., local, proportional, or joint, and schedules thereof, and provisions for filing and publication of such schedules by carriers subject to the act; and including the extent to which the traffic and revenues of carriers subject to the act are affected by the operation of motor buses or motor trucks, or both, by or in connection or competition with such carriers subject to the act, with a view of making such findings and entering such orders as the facts developed by such investigation may warrant, and for the purpose of making such recommendations to Congress."

All common carriers by rail and water are made respondents to the proceeding. Hearings will be held at such places as the commission may direct.

$22,088,000 Bond Issue for Improvements at Detroit

The largest issue of city bonds in the history of Detroit was recently authorized when the city council instructed the city controller to advertise for bids for a total issue amounting to $22,088,000. A part of this issue was authorized in the 1926-27 budget but most of it was authorized in previous years.

Of the amount covered in the issue, $5,500,000 will be used for the extension of the water system; $4,800,000 for new schools and additions; $4,000,000 for new sewers, chiefly in the east side district; $3,000,000 for the extension of the city's lighting facilities and for continuing the work on the new municipal power house at Morrell Street; $1,008,000 for general public improvements; $1,050,000 for an addition to Receiving Hospital and for building a nurses' home; $750,000 for the House of Correction, and $480,000 for grade separation work.

Dredging in Niagara River Stopped

Army engineers have ordered the cancellation of permits for dredging sand and gravel from the Niagara River above the falls. This action was taken in view of a report that the dredging had lowered the level of Lake Erie slightly.

Street Improvement Program for $10,000,000 at St. Paul

Street widenings and extensions at an aggregate cost of about $10,000,000, in order to open up new traffic routes and improve existing routes, have been recommended by the City Planning Board at St. Paul, Minn. It is proposed to pay 40 per cent of the cost by assessment against property and 60 per cent by a new tax which will increase as property values rise.

Surveys for Long Power Line to Be Made by Airplane

The Ontario Hydro-electric Power Commission announces that work is to be commenced immediately on the high tension transmission line between Ottawa and Toronto, about 220 miles. This line will be used to carry power to Western Ontario from the developments of the International Paper Company on the Gatineau River, a few miles from Ottawa. The preliminary reconaissance will be done by airplane. The country through which the survey is to be run is suited to show the advantages of such a survey.

Milwaukee Must Heed State Limit on Building Heights

Under the ruling of a lower state court, from which an appeal will be taken, that part of the new zoning ordinance of Milwaukee, Wis., which permits buildings to be carried to a height of 250 ft. is unconstitutional. The court held that the city has no right, under the home rule constitutional amendment, to raise the height limit of 125 ft. set by the legislature. It is reported that the decision will postpone, and if upheld by the highest court of the state, prevent the carrying out of several projects for high buildings planned since the passage of the zoning ordinance.

Commission to Study Proposed Tunnel Under Cascade Mts.

Governor Hartley of the State of Washington, acting under a request from the State Legislature, has appointed a commission to report upon the feasibility of building the long projected tunnel for railway and highway traffic under the Cascade Mountains. Construction of the tunnel is being advocated by the Provisional Cascade Tunnel Association. The members of the new commission are J. G. Kelley, editor and publisher of the *Walla Walla Bulletin*, Everett G. Griggs, president of the St. Paul & Tacoma Lumber Co., and John P. Hartman, a lawyer of Seattle, Wash. The tunnel was first proposed about twenty years ago by the late Gen. H. M. Chittenden. The location is not far north of the present Cascade tunnel of the Great Northern R.R. It begins at a point near Skykomish on the west side and extends to a point near Leavenworth on the east side, a distance of about 30 miles.

Flood Damage to Puddingstone Earth-Fill Dam

Further details have been received on the overtopping of the earth-fill Puddingstone dam built in southern California by the Los Angeles County Flood Control District. Report of damage to this structure appeared in connection with news of other storm damage in *Engineering News-Record*, April 22, p. 665.

This dam was 50 ft. high and was faced with a concrete apron up to an elevation 20 ft. below the crest. The apron is reported to have been placed merely for the purpose of holding water in a pool above the dam for use in hydraulicking material into the main structure and it was not planned to carry the concrete any higher. No spillway had been provided, as it was planned to raise the dam to greater height; provision for flood runoffs consisting of a 4x7-ft. tunnel. At the time of the flood this tunnel became partly clogged with brush and driftwood. Strenuous efforts were made during the night preceding the break to keep the tunnel clear but the water behind the dam rose steadily and the structure was overtopped at 4:30 a.m., April 7.

The extent of the damage is shown in the accompanying illustration. The capacity of the reservoir for the 50-ft. dam was about 500 acre-ft. and it is estimated that when the break occurred the discharge was at the rate of 10,000 sec.-ft. for 15 minutes, releasing a total of about 350 acre-ft.

PUDDINGSTONE DAM AFTER BEING OVERTOPPED APRIL 7

New York Barge Canal to Have New Fleet of Boats

Beginning with the opening of navigation on the New York State Barge Canal, the Munson Inland Water Lines, Inc., will put in operation a fleet of 75 vessels upon the canal, according to an announcement of Frank C. Munson, president of the newly organized company and of the Munson Steamship Lines. The fleet of boats will be operated in connection with the coastwise steamers of the company.

Engineering Endowment Society Committee Appointed

At the meeting of Engineering Foundation in New York May 19, W. L. Saunders, president of United Engineering Society, announced that in response to a request from Engineering Foundation last December and from the Founder Societies of Civil, Mining, Mechanical and Electrical engineers, United Engineering Society had appointed an endowment committee to seek increase of funds for Engineering Foundation and Engineering Societies Library.

The personnel of this committee is made up of nominees of the four societies and other members, as follows: *Ex officiis:* W. L. Saunders, president, United Engineering Society, chairman; L. B. Stillwell, chairman, Engineering Foundation; Sydney H. Ball, chairman, Library Board. Nominees of American Society of Civil Engineers: Charles F. Loweth, H. deB. Parsons, Ralph J. Reed; nominees of American Inst. of Mining and Metallurgical Engineers: D. W. Brunton, J. V. N. Dorr, Thomas Robins; nominees of American Society of Mechanical Engineers: J. W. Lieb, Wynne Meredith, E. A. Simmons; nominees of American Institute of Electrical Engineers: Calvert Townley, H. A. Lardner, E. Wilbur Rice, Jr. Members-at-large: Charles F. Rand, James H. Perkins, and H. Hobart Porter.

No hectic "drive" is planned, but an organization is being created to maintain a well-considered and persistent endeavor to get larger financial resources for Engineering Foundation and Engineering Societies Library as their opportunities for service develop.

Work to Start on Dam in Quebec

It is announced by the Quebec Streams Commission that work will be started immediately on a new dam on the Mekinac River, about 20 miles from Shawinigan Falls, Quebec. The work is to be done by the Shawinigan Water and Power Co. and will cost approximately $500,000.

RANDOM LINES

Our Humorous Congress

The following Joint Resolution was presented to the House of Representatives on April 12 by Representative Appleby, of New Jersey, and has been printed as H. J. Res. 224, 69th Congress, 1st session:

Whereas the United States is again being asked for more money ($250,000) to make a further survey for a New York stagnant-water ship canal from the Great Lakes to the Hudson River, a proposition which has several times been pronounced inadvisable by Government engineers; and

Whereas it can be shown that all the benefits derivable from such a canal would be afforded by the proposed Great Eastern Freight Railroad between Lake Erie and New York Lower Bay, a survey for which is requested by S. J. Res. 79 and H. J. Res. 214; and . . .

Whereas if a favorable report should be rendered upon a survey for the Great Eastern Freight Railroad and show that it can be made an economical means of transporting heavy gross freights between the Great Lakes and the Atlantic it will automatically tend to facilitate a satisfactory arrangement between the United States and the Canadian Governments concerning the joint construction and operation of the Great Lakes-Saint Lawrence Canal, and

Whereas if Congress is determined to have a ship canal through New York State it can be further shown that instead of any stagnant-water ship canal there should be constructed an aqueduct ship canal through which water from Lake Erie would forever provide the necessary water for municipal purposes to many of the growing towns and cities of New York, Pennsylvania, and New Jersey by connecting the headwaters of the Susquehanna and the Delaware and the Hudson Rivers with it, and specifically to provide water during periods of drought for the hydraulic energy to be developed for the propulsion of the proposed Great Eastern Freight Railroad; and

Whereas it can be shown that the proposed aqueduct canal because of its being made largely by embankment for many miles can be made more than 40 ft. deep and more than 400 ft. wide at less than half the cost per mile for the excavation heretofore necessary for any proposed stagnant-water ship canal 25 ft. deep; it is self-evident that practically the same embankment would confine a sheet of water 500 ft. wide that would be required to confine one of the same depth 20 ft. wide; and

Whereas an aqueduct canal because of its passing through rural districts and being made largely by embankment would not be greatly obstructed by bridges, as travel could be made to go under it by tunnels, which would be only slightly depressed below the natural surface of the country, while a tunnel passing under an excavated canal, as all proposed stagnant-water canals largely are, would average about 25 ft. deeper; and the number of locks required would be only about one-tenth the number that would be required for any such stagnant-water canal: Now, therefore, be it

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled. That if an appropriation shall be granted for a new survey for a ship canal between the Great Lakes and the Hudson River that such appropriation shall not be employed to make a further survey for a semistagnant-water ship canal, but instead shall be employed to survey and provide estimates of the cost of constructing a large aqueduct ship canal which shall conduct waters from Lake Erie to the Hudson River, with connections between such canal and the headwaters of the Susquehanna and the Delaware Rivers, so that in addition to providing a wide and deep ship canal having a continuous declevity from Lake Erie to the Hudson River, its waters can be used to provide many growing towns and cities in New York, Pennsylvania, and New Jersey with water, and specifically to provide water during periods of drought for the hydraulic energy to be developed for the propulsion of the proposed Great Eastern Freight Railroad.

Detroit Paving Suit Deadlocked

The second trial of three officials of the Detroit Asphalt Paving Co., accused of conspiracy in restraint of trade, resulted in a deadlock of the jurors and the jury was dismissed by Judge E. J. Jefferies of the Detroit Recorder's Court. At the time the jury was dismissed it was not announced by the City corporation counsel whether or not a third trial would be held.

The charge against the defendants in the case, Julius Porath, John A. Mercier and Thomas E. Currie, grew out of the one-man grand jury investigation of city affairs conducted by Judge Frank Murphy of the Recorder's Court.

The Detroit Asphalt Paving Co. has been awarded contracts for paving a large percentage of the new streets for the paving of which bids have been asked during the present construction season. The sum of $400,000 was provided in the current budget to permit the Department of Public Works to enter the paving field in competition with private contractors.

Engineering Course at Tennessee to Offer Practical Training

The University of Tennessee, beginning with the fall term, will offer to students in engineering who have completed one year of residence study an option of continuing the regular course with three years of further residence study or a co-operative course requiring four years additional study in which the students will attend the university for six months of the year and work in the industry for the other six. In this new course students will alternate between work and study for periods of three months, students working in pairs alternating their periods of work and study so that the position in industry is filled continuously.

Oil Pollution Conference to Meet in Washington June 8

The preliminary conference of experts of maritime nations for the consideration of problems of oil pollution of navigable waters, invited by the United States Government to meet in Washington, will convene there on June 8. The governments of Belgium, Denmark, France, Germany, Great Britain, Greece, Italy, Japan, The Netherlands, Norway, Spain and Sweden have been invited to send delegates, and all the countries except Belgium and Greece have signified their intention to do so.

The United States Government will be represented by former Senator Joseph S. Frelinghuysen of New Jersey, chairman of the Executive Committee of the National Anti-Pollution and Conservation League; Stephen Davis, solicitor of the Department of Commerce, and Dr. Arthur N. Young, economic adviser of the Department of State and chairman of the Inter-departmental Committee on Oil Pollution of Navigable Waters.

Technical assistance will be provided the members of the committee by the following members of the Inter-departmental Committee: Dr. R. R. Sayers, chief surgeon of the Bureau of Mines; Major G. R. Young and G. S. Lincoln of the War and Navy Departments; Talbott Denmead of the Department of Agriculture; Dr. Lewis Radcliffe, Deputy Commissioner of Fisheries; and W. S. Maginnis of the U. S. Shipping Board.

Favorable Action Expected on East Bay Water Project

Favorable action by the Federal Power Commission on the application of the East Bay cities for rights on the Mokelumne River in California, is foreshadowed by the receipt of a favorable report on the project from the engineers who made the field examination.

A joint hearing by the Division of Water Rights of California and representatives of the Federal Power Commission to consider objections to granting these rights was held in October, 1926, and was reported in our issue of Nov. 19, 1926, p. 851. Since then the California Division of Water Rights has given its approval, *Engineering News-Record*, April 29, 1926, p. 708, but the Federal Power Commission has not rendered its decision.

Railway to Isolated Power Site Well Under Way

The railway being constructed by the Spruce Falls Power & Paper Co., Ltd., from Kapuskasing, on the Canadian National Ry., in northern Ontario, northward to Smoky Falls and Devil Rapids, two power sites on the Mattagami River, is well under way. Contract for the construction was let to the firm of Morrow & Beatty, of Peterborough, Ont., some time ago. The paper company has obtained a lease of the power site and expects to develop power for use in increasing its output of paper.

Engineering Societies

Calendar

Annual Meetings

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Buffalo, N. Y., June 5 and 7, 1926.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Buffalo, N. Y., June 7-11, 1926.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Philadelphia, Pa., June 14-17, New York City, June 18-19, 1926.

SOCIETY FOR PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Meeting, State University of Iowa, Iowa City, June 16-18, 1926.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J.; June 21-25, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Summer Meeting, Seattle, Wash., July 14-16; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Providence, R. I., Sept. 14-17, 1926.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, Lawrence, Kansas; Annual Convention, Colorado Springs, Colo., Sept. 21-23, 1926.

The Arizona Division of the American Association of Engineers held its annual convention at Phoenix May 9. Dean G. M. Butler of the Engineering School of the University of Arizona at Tucson spoke on "The Engineer and his Relation to the Public."

The New York State Society of Professional Engineers and Land Surveyors has elected the following officers for the year 1926-7: James M. Welsch, president; R. J. Smyth and W. T. Husson, vice-president; Edward T. Ebert, secretary, and J. W. Osberg, treasurer.

Personal Notes

OSCAR W. SJOGREN has been elected president of the American Society of Agricultural Engineers. Professor Sjogren is chairman of the department of agricultural engineering at the University of Nebraska, from which he graduated in 1915 in agricultural engineering.

P. N. DANIELS, until recently senior sanitary engineer of the New Jersey State Department of Health, has become city sanitary engineer for Trenton, N. J., under the Department of Public Works of that city. Part of his duties will be the supervision of the new 30-m.g.d. sewage-works now nearing completion.

EDWARD W. TREE, until recently editor and publisher of *Good Roads*, has joined the Interflash Signal Corporation, 120 Broadway, New York City, as advertising manager, this company being the manufacturer of flashing signals for marine, aviation and highway work. Mr. Tree is a graduate of the Polytechnic Institute, of Brooklyn, and has long been identified with technical advertising and publishing.

ALFRED MULLIKIN, lately connected with William S. Lozier, Inc., civil and sanitary engineers, in charge of the construction of the sewage disposal plant in Brighton, N. Y., has been appointed town engineer of Mount Desert, Maine, with headquarters at Northeast Harbor, Maine, where he will have charge of projects in municipal sanitation and the construction of bridges and highways. During the War Mr. Mullikin served as captain of engineers, reserve, in sanitary engineering.

WILLIAM SPANN has been appointed city engineer of St. Joseph, Mo. Mr. Spann has been connected for four years with the Missouri State Highway Department as division engineer, construction engineer, and more recently as chief of surveys and plans.

A. R. SCHUH, formerly with the Wisconsin State Highway Commission, has been appointed city engineer of Waukesha, Wis.

MARTIN FISHER, formerly in charge of the Division of Surveys, city of Detroit, has been appointed assistant city engineer, Detroit, Mich.

ISAAC S. WALKER, who for a number of years has been general manager of the New Chester Water Co., of Chester, Pa., and its subsidiaries, has just been elected president, and is now president and general manager of the company.

L. MURRAY GRANT has been appointed superintendent of the municipal water system of Seattle, Wash. Mr. Grant is a graduate of Purdue University and was until recently vice-president of the Manufacturers' Association of Washington. He was formerly city engineer of Spokane. He is a past president of the Western Washington Section of the American Society of Civil Engineers.

W. W. DELONG, architect and engineer, Appleton, Wis., has retired from the practice.

W. S. CARUTHERS, an engineer with the California State Highway Commission for a number of years, has been appointed division engineer of Division 9, with headquarters at Bishop, Calif.

M. R. RICE, for the last three years a member of the military staff of Purdue University, is to become assistant to the president of the Walb Construction Co., LaGrange, Ind., on June 1. Capt. Rice studied engineering at the University of Kentucky.

H. W. DESAUSSURE, Jacksonville, Florida, has resigned his position as chief engineer for San Jose Estates and has opened a general engineering office in conjunction with R. P. WILSON, former city engineer for Daytona Beach, Florida, and assistant engineer for the Florida East Coast Hotel Corporation at Palm Beach. The new company's name is H. W. DeSaussure Co. and its offices are in the Dyal-Upchurch Building, Jacksonville. Mr. DeSaussure was formerly assistant engineer of maintenance-of-way for the Florida East Coast Ry.

WILLIAM D. HUDSON announces the formation of the Wm. D. Hudson Co., consulting engineers St. Louis, Mo. The company is affiliated with Harland Bartholomew and Associates.

EDWARD G. LEE, who has been chief designing engineer on the new Gulf Island power development, near Lewiston, Me., has left the Central Maine Power Co. to enter the hydraulic engineering department of Stone and Webster, Inc., of Boston.

Obituary

LEVI HUSSEY, Brooklyn, N. Y., retired civil engineer who assisted in the construction of the Cape Cod Canal, died May 27 aged 88 years. Mr. Hussey not only was connected with the construction of the canal but was one of those who advocated the building of a canal between Buzzard's Bay and Massachusetts Bay and helped promote the project.

JACOB FLOESCH, Rochester, N. Y., president of Floesch & McGovern, died May 20 at his home in Rochester at the age of 68 years. Mr. Floesch was chief engineer of the Buffalo, Rochester & Pittsburgh Ry. from 1900 to 1907, and constructed the Clearfield & Mahoning branch, also the Allegheny & Western road. In 1907 he took charge of construction in Canada of the Moncton branch of the Grand Trunk Pacific Ry. He was connected with the construction of several other railroad sections and branches in the United States and Canada, and besides the railroad work handled also other large construction and mining operations.

JACOB EICHEL, Evansville, Ind., for fifty years identified with construction in that city, died May 6 aged 82 years. Mr. Eichel was born in Alsace, France, and came to this country at the age of 14 and settled in Evansville. Educating himself while working in various occupations, he became engaged in construction, and his construction activities ranged from building the first paved street in Evansville to carrying out, with his associates, contracts with the government for dams and extensive river and harbor improvements on the Ohio and its tributaries. He also was engaged in commercial building construction, and was responsible for the organization of the first electric light and gas company in the city of Evansville.

CLARENCE T. FERNALD, chief engineer of maintenance-of-way of the Boston elevated railways, died May 13 at his home in Melrose, Mass., aged 59 years. Mr. Fernald was a graduate of Massachusetts Institute of Technology, and a past president of the Boston Engineers' Club.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Additional Exhibitors at Waterworks Convention

In addition to the list published in these pages in the May 13 issue, the following manufacturers have applied for space at the exhibit to be held in connection with the convention of the American Water Works Association in Buffalo, N. Y., June 7-11:

Republic Flow Meters Co.
American City
Public Works
Lead Lined Pipe Co.
Builders Iron Foundry Co.
The Lock Joint Pipe Co.
Barber-Greene Co.
Badger Meter Mfg. Co.
Michigan Valve & Fdry. Co.
Glauber Brass Mfg. Co.
Sims Pump Valve Co.
Wailes-Dove-Hermiston Corp.
H. W. Clark Co.
Hydraulic Development Co.
Van Gilder Water Meter Co.
The American Well Works
La Motte Chemical Products Co.
Iowa Valve Co.
National Cast Iron Pipe

Motor Truck Industry Has Another Record Year

Motor truck production in 1925 showed an increase of 33 per cent over 1924, while the latter was 11 per cent under 1923 production, according to the annual report of the National Automobile Chamber of Commerce published in its booklet, "Facts and Figures of the Automobile Industry, 1926 Edition." These percentages are based on production figures of 497,452 in 1925, 374,317 in 1924 and 392,760 in 1923. Some of this increase was probably due to the increase in motor buses in use in the United States to a total of 70,000 as of January 1, 1926 as compared with 53,000 as of January 1, 1925. These estimated figures are said to account for 80 per cent of the total.

The accompanying tables give some pertinent statistics and are self-explanatory.

MOTOR TRUCK REGISTRATION

		Per Cent Gain Over Previous Year
1921.....	1,118,520	13
1922.....	1,375,725	17
1923.....	1,612,569	23
1924.....	2,133,028	17
1925.....	2,441,709	14

TRUCK PRODUCTION BY CAPACITIES

(United States and Canada) Per Cent

Size	1919	1920	1921	1922	1923	1924	1925
¾ ton or less	21	19	22.9	24.5	11.3	10.8	9.5
1 ton.....	47	51	54.1	58.5	70.1	71.4	70.6
1½ ton.....	8.5	11	4.8	2.8	7.7	7.7	8.8
2 ton.....	10	8	7.6	5.5	3.8	2.2	2.5
2½ ton.....	5.5	4	2.7	4.5	3.2	3.8	3.3
3½ ton.....	3.8	4	2.3	1.3	1.7	1.0	1.2
5 ton.....	2.9	2	3.2	2.3	1.2	1.8	1.6
Over 5 ton..	1.3	1	2.4	0.6	1.0	1.3	2.5
	100	100	100	100	100	100	100

Passenger car production increased from 3,243,285 to 3,839,302. Outstanding among the developments of the year also was the 39 per cent gain in exports of motor vehicles over 1924. All the above figures include production of plants located in Canada, making motor vehicles of United States design. Figures are also given showing that the United States produced 87½ per cent of the world's production in 1925, Canada 3.5 per cent, and the other countries the remaining 9 per cent. The total world production for 1925 was 4,800,321 motor vehicles.

Business Notes

FULLER & JOHNSON MFG. CO., Madison, Wis., announces the election of the following officers: C. L. McMullen, formerly vice-president, president and director of sales; W. W. Gore, vice-president, director of engineering; C. K. Swafford, vice-president, director of production; H. C. Wolf, treasurer, director of purchase; Paul Kney, secretary, director of credit and finance; M. J. Esser, assistant treasurer, director of accounting. The above officers constitute the board of directors.

TIMKEN ROLLER BEARING CO., Canton, Ohio, has made the following changes in its personnel: T. F. Rose, formerly assistant branch manager, Chicago, has been appointed branch manager, Cincinnati; H. C. Sauer, formerly assistant branch manager, Cleveland, has been appointed branch manager, Detroit; Fred G. Rumball, formerly branch manager, Kansas City, has been promoted to the position of sales engineer, automotive division of the company, with headquarters at Cleveland. J. M. Carey will fill the position of branch manager at Kansas City. The branch office located in Baltimore was closed May 1 and the service requirements of Timken customers in this territory will be supplied through the Richmond, Pittsburgh, and Philadelphia branches.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa., announces that the volume of sales billed during year ended March 31, 1926, showed an increase of about $8,000,000 over sales for the year ended March 31, 1925. Sales for the past fiscal year aggregated $166,006,800.

INTERNATIONAL CREOSOTING & CONSTRUCTION CO., Galveston, Texas, has elected George Sealy as chairman of the board of directors, succeeding the late John Sealy. J. D. Latimer, manager of the tie and timber department, has been appointed vice-president and general manager; H. A. West, secretary and treasurer, has been appointed vice-president. R. J. Calder continues as president of the company.

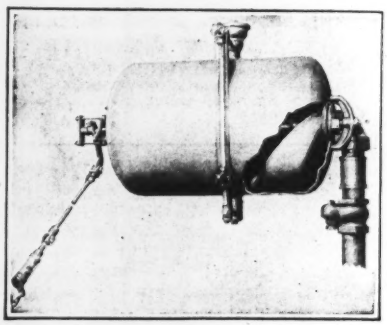
UNITED FUEL & SUPPLY CO., Detroit, Mich., announces a change in its name to the C. N. Ray Corp., and also the formation of the Ray Sand & Gravel Co. to operate its pit property.

Equipment and Materials

Water Control on Pavers by New Water Delivery System

Besides getting the water into the mixer drum in about 10 sec. and with a minimum of dribble, the new pressure water system that has been designed by the Chain Belt Co., Milwaukee, Wis., for use on its 27-E paver also measures the water with an accuracy that is claimed to be as great as that obtained by weighing apparatus.

The water system consists essentially of a 42-gal. drum-type tank from which the quantity of water delivered is controlled by a siphon at one end which can be rotated about the axis of the tank. When the mouth of the



siphon is uncovered and the air breaks the siphonic action, the shape of the siphon is such that all of the water above its mouth is discharged and the flow stops almost immediately. The quantity is therefore dependent on the level of the siphon mouth, which level can be varied by rotating the siphon. This rotation is effected by a rod carried through the end of the tank opposite the outlet and connected with the screw handle apparatus shown in the illustration.

Both shop and field tests covering several months have been made on this system, the latter in conjunction with the Iowa State Highway Department. In the shop tests the tank was so mounted that it could be tilted to compare with its position in a paver operating on 5 and 10 per cent grades and various curve elevations. Testing apparatus was so arranged that the water discharged was weighed directly on platform scales so that a comparison could be made between the theoretical amount of water and the actual amount discharged. In addition to the tests made with the tank tipped, others were made when it was level, but with the position of the siphon varied by a

half turn of the screw handle each time. One turn of the crank was found to equal 0.426 gal. The results indicated that with the tank level the quantities desired can be obtained within 1 lb. An average variation of about 4 lb. was obtained with the tank tipped at the various angles, the greater variation being most evident on an "upgrade" position.

Speed was attained by enlarging the discharge from 2½ to 3 in. and straightening it out as much as possible. Reduction of the dribble period was also noteworthy. With a setting of 25 gal. or 208 lb., 192 lb. discharged in 6 sec., while the last 16 lb. required only 4 sec. more. With the old system used heretofore by the company 25 gal. would be discharged as follows: 166 lb. in 15 sec. and the last 42 lb. in from 30 to 40 sec. more. Elimination of the dribble by the improved siphon is responsible for the accurary of the new system, according to Charles Ball, chief engineer of the company.

Colored Finish Plaster

A colored sand-float finish plaster, called Plastint, has been developed by the United States Gypsum Co., Chicago, as an inexpensive interior plaster that can be applied with the ordinary tools. Mineral pigments supply the tints in nine colors—cream, gold, pearl, buff, grey, tan, blue, green, rose and white. The plaster also may be had in rough, medium or smooth float finishes, which are produced by the use of cork, wood, carpet or felt floats.

The material is shipped in 80-lb. paper bags and its coverage is from 65 to 70 sq.ft. per bag. Ten quarts of water are mixed with each bag of the colored plaster. After allowing to soak 10 to 20 min., it is hoed to a creamy consistency and troweled on.

Long Portable Belt Conveyor Used With Trenching Machine

A portable belt conveyor 100 ft. long has recently been built by the Northern Conveyor & Mfg. Co., Janesville, Wis., for the contracting firm of Hansen & Willadsen, Springfield, Ill. The equipment is to be attached to a trenching machine for backfilling purposes.

This belt conveyor is one of the largest, if not the largest, portable belt conveyor that has been built to date. It is claimed that its capacity is slightly in excess of 3 tons per minute. The weight of the complete machine is slightly over 19,000 lb. Power for driving the belt is furnished by a four-cylinder, 20-hp. Continental motor.

New Type Paving for Railroad Crossings

A new type crossing paving consisting of pre-formed slabs of interlocking design and so arranged as to tie into specially shaped sections adapted to fit into the web and around the joints of all types of rail, is being introduced by the Philip Carey Company, Cincinnati, Ohio. The pavement slabs are a mixture containing asphalt, rag fiber and mineral matter and are formed under high pressure. The use of the rag fiber is claimed to give great strength as the fibers interlock and prevent

creeping. Also the absorbent quality of the rag fiber makes possible the use of a high percentage of asphalt, resulting in longer life.

The rail filler sections in 3 ft. lengths are placed first following which timber stringers are placed longitudinally and resting on the ties. On top of these stringers the pavement slabs cut to proper length are placed perpendicular to the rails, their ends resting on the shoulders provided in the rail filler section. The joints in the transverse slabs are similar to those used in ship lap lumber. Filling the open joints with asphalt pitch completes the job.

The advantages listed for this type of crossing are, that track and pavement form one structure, that installations may be made under all weather conditions, that it is frost and water proof, and will knit and heal under traffic.

Having the characteristics of lumber as regards shape and manner of application any skilled track gang can install the crossings properly.

7-S Non-Tilting Mixers Mounted on Crosswise Trucks

The 7-S non-tilting mixers manufactured by the T. L. Smith Co., Milwaukee, Wis., can now be furnished on crosswise trucks for end discharge similar to a paver. This arrangement is suitable where the job is strung out as in conduit, sewer, curb and gutter and in sidewalk and alley paving. The standard frame is arranged to be bolted to the new unit.

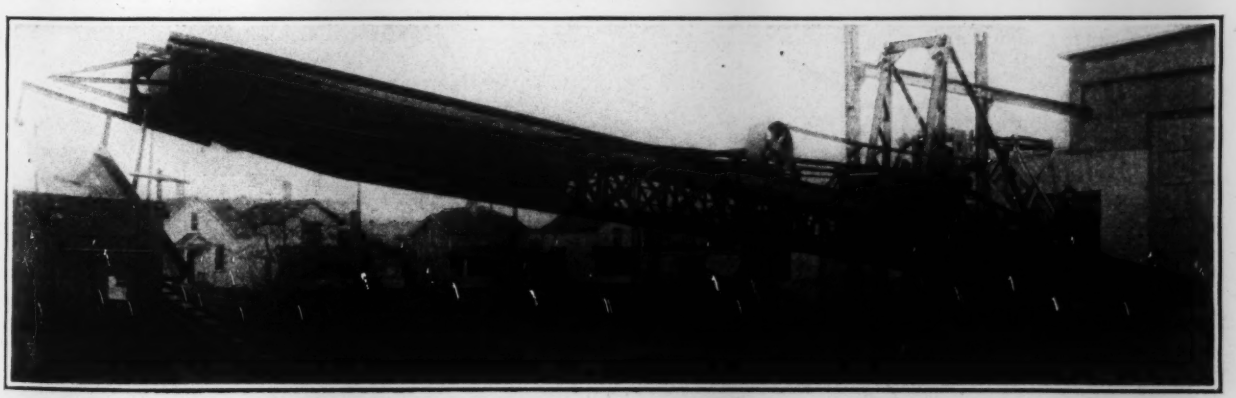
Publications from the Construction Industry

Road Machinery—GOOD ROADS MACHINERY CO., INC., Kennett Square, Pa., makes available its latest catalog, entitled "Everything for the Road Maker." The catalog contains 64 pp. of descriptions and illustrations setting forth the company's complete line of equipment.

Quarrying — ARMSTRONG MFG. CO., Waterloo, Iowa, entitled its new 1926 catalog "The Story of the Quarry." The 64-p. booklet traces the history of big blast hole drilling from the first wooden drill to the modern all-steel drill. It contains much information on different quarrying methods and practices, and semi-technical data on drilling and blasting. Many quarry illustrations are given together with descriptions and illustrations of machinery, tools and accessories used in quarrying work.

Alloy Steel—AMERICAN SHEET & TIN PLATE CO. has published a booklet summarizing scientific evidence on the value of alloying steel with copper so as to resist rust. The booklet of fifteen pages devotes a page each to conclusions expressed by scientists in various technical society proceedings and technical publications.

Swimming Pools—GRAVER CORP., East Chicago, Ind., in its new bulletin No. 500 entitled "The Water Supply for Swimming Pools" gives a description of its refiltering and recirculating system for hygienically safe swimming pools. The bulletin is illustrated with views of the equipment and of many types of pools and gives data on the design, construction and operation of the Graver system.



Engineering News-Record Statistics of the Construction Industry

June 3, 1926 — *in the United States* — Vol. 96, No. 22

Engineering News-Record CONSTRUCTION COST Index Number (1913 = 100)

MONTHLY

January, 1925 to Date

June, 1926	204.80
May, 1926	207.30
June, 1925	204.60
Peak, June, 1920	273.80
1913	100.00

1925

Jan.	210.40	May	207.20	Sept.	202 10
Feb.	209.70	June	204.60	Oct.	205.35
March	210.20	July	204.60	Nov.	205.95
April	209.55	August	204.60	Dec.	205.95

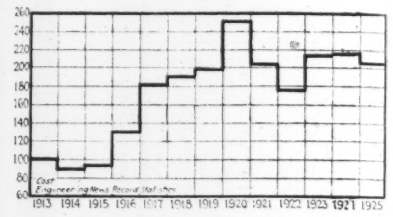
1926

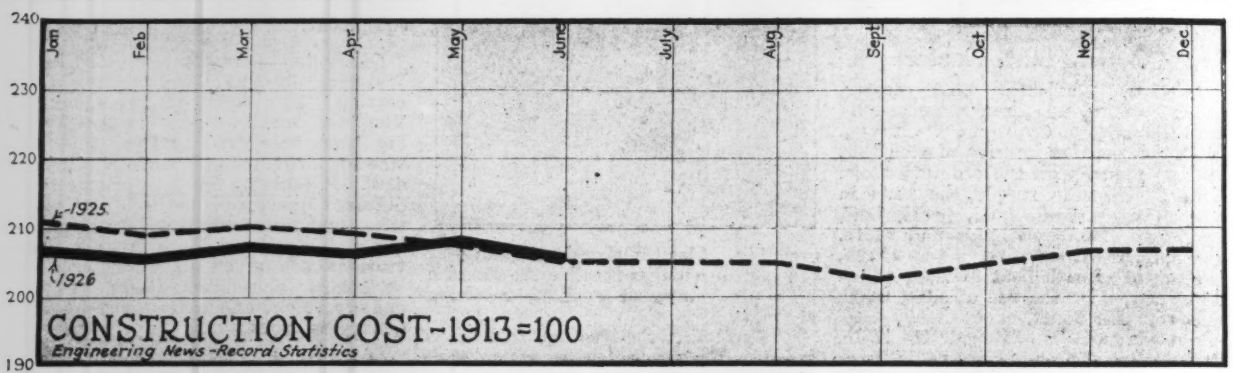
Jan.	207.15	Feb.	206.55	Mar.	207.65
		April	207.05		

ENGINEERING NEWS-RECORD'S Construction Cost Index Number is 1.2 per cent below May, 1926, owing to decline in cost of structural material. The average rate for common laborers is still 55c. per hr. for the entire country as compared with 54½c. two months ago and 53c. at this time last year. Thus, general construction cost is a fraction of a per cent above June, 1925, 25 per cent under the peak and 104 per cent above the 1913 level.

YEARLY

1913 to 1925





Engineering News-Record CONSTRUCTION VOLUME Index Number (1913 = 100)

MONTHLY

January, 1925 to May, 1926

May, 1926	254
April, 1926	233
May, 1925	209
Peak, August, 1925	266
1913	100

1925

January	141	May	209	September	262
February	145	June	214	October	233
March	161	July	178	November	194
April	211	August	266	December	206

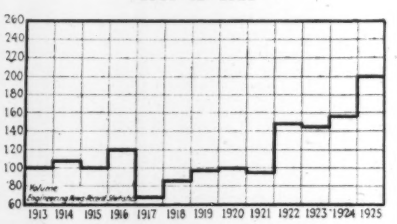
1926

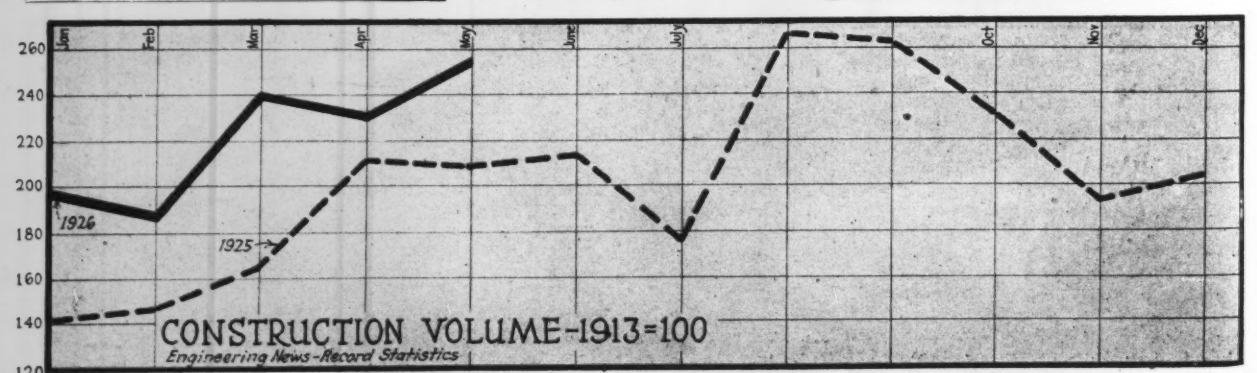
Jan.	198	Feb.	187	Mar.	240

ENGINEERING NEWS-RECORD'S Construction Volume Index Number is 254 for the month of May, and 201 for the whole of 1925, as against 100 for 1913. This means that the actual volume of construction in 1925 (not the mere money-value of the contracts let that year) is 101 per cent above the volume of construction for 1913. The monthly volume number, 254 for May, 1926, contains the increment of construction and indicates the rate at which contracts are being let as compared with 1913 awards.

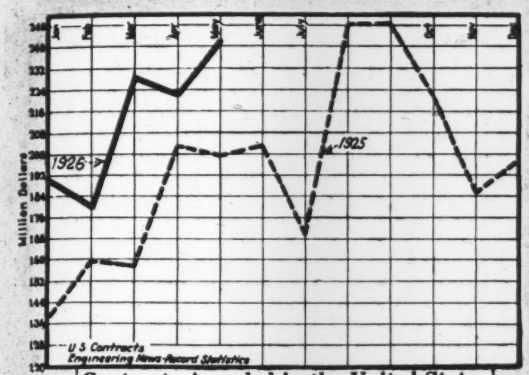
YEARLY

1913 to 1925

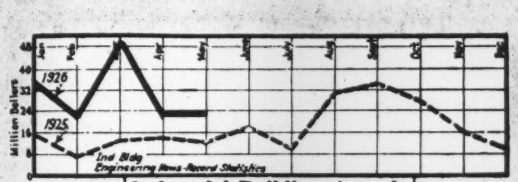




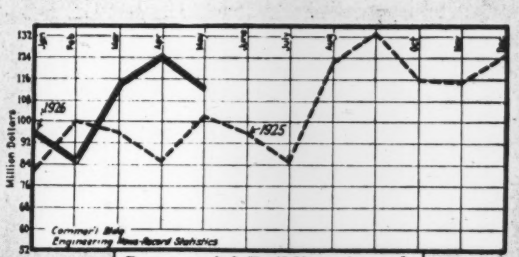
Monthly Statistics of the Construction Industry



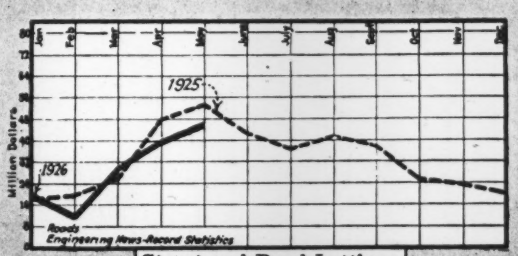
Contracts Awarded in the United States
Reported in E. N.-R.



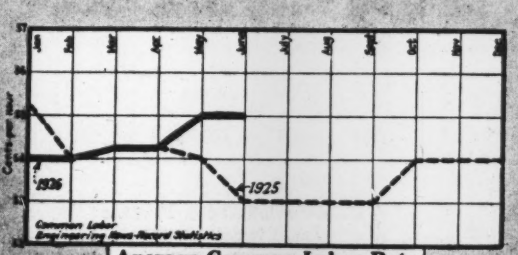
Industrial Building Awards
$40,000 and Over



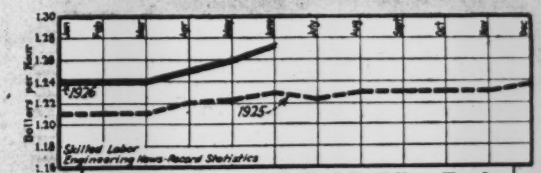
Commercial Building Awards
$150,000 and Over



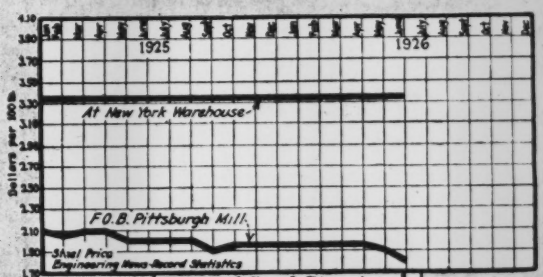
Street and Road Lettings
$25,000 and Over



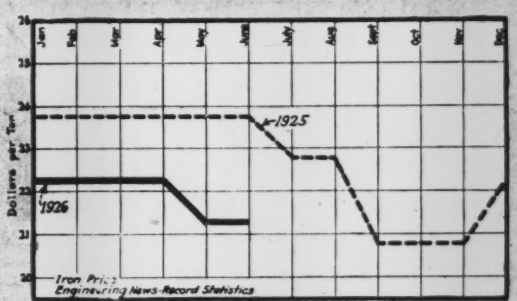
Average Common Labor Rate
Pick and Shovel Men



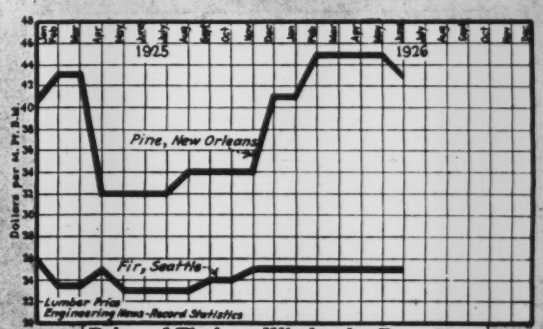
Average Wage of Skilled Building Trades
Bricklayers, Carpenters and Steel Erectors



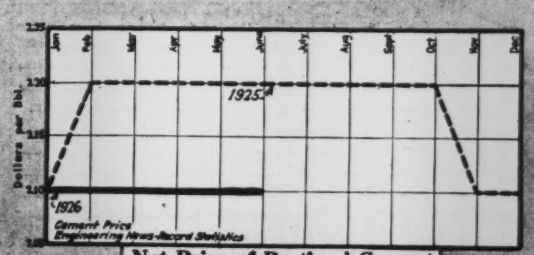
Price of Steel Structurals
Shapes 3-In.; Plates ¼-In.



Price of Basic Pig Iron
F.o.b. Pittsburgh

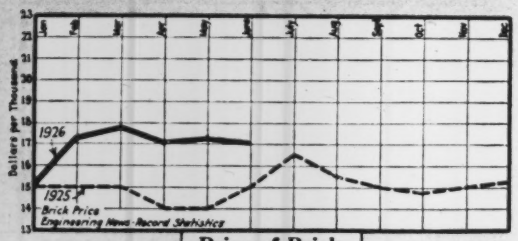


Price of Timbers, Wholesale, Base Sizes
Car Lots to Contractors

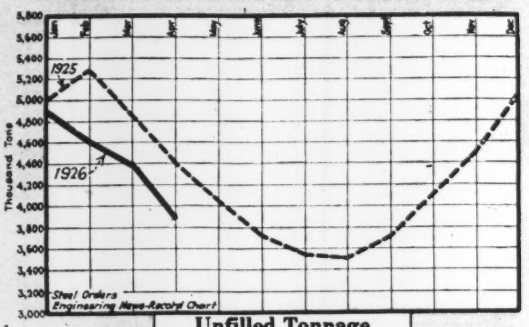


Net Price of Portland Cement
Car Lots, F.o.b. Chicago

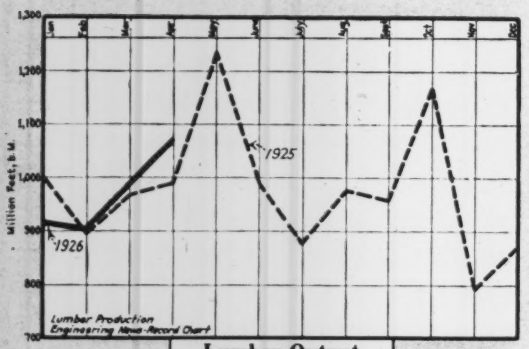
Monthly Statistics of the Construction Industry



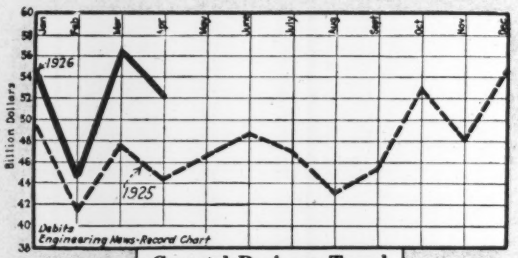
Price of Brick
At Dock, New York



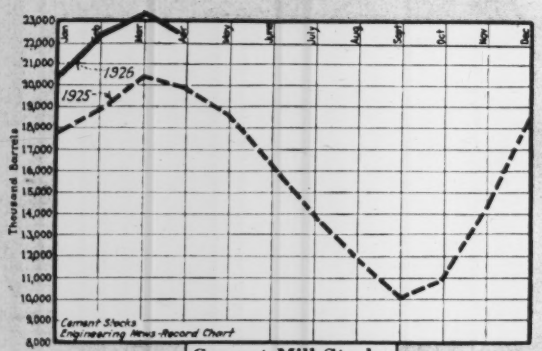
Unfilled Tonnage
On Books of U. S. Steel Corp.



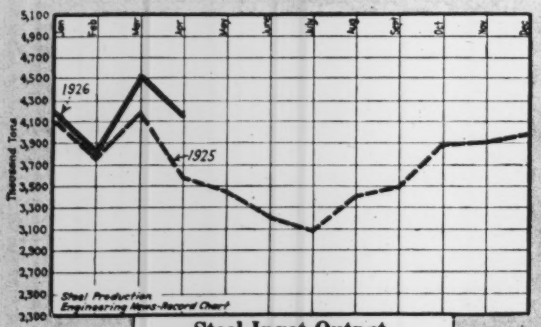
Lumber Output
Nat. Lumber Mfrs. Assn.



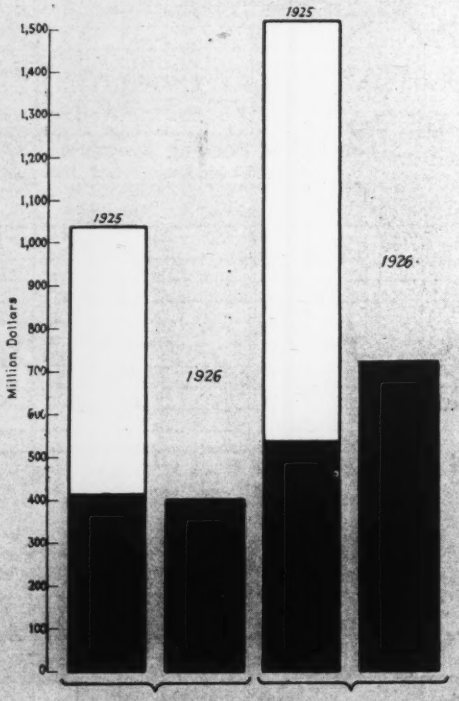
General Business Trend
Bank Debits—Federal Reserve



Cement Mill Stocks
Bureau of Mines



Steel Ingot Output
Gross Tons; Am. Iron and Steel Inst.



Public—Contracts—Private
Jan. 1 to date
Reported by E. N.-R.

May Construction Volume Heavier Than Any Month Last Year Except August and September

Gain Greater in Construction Other Than Buildings

CONTRACTS awarded on engineering construction projects throughout the United States amounted to $241,337,000 during May as compared with $199,307,000 for the same month last year.

The minimum value per project adopted in each class was as follows: Water-works and excavation, $15,000; other public projects, $25,000; industrial buildings, $40,000; commercial, public and other buildings, $150,000.

Work definitely reported as proposed, at the minimum mentioned for each class, amounted to $367,745,000 for the month just closed as compared with $330,814,000 for May, 1925.

A comparison of cumulative totals reveals the fact that contracts awarded, Jan. 1 to June 1, 1926, totaled $1,122,382,000 as against $934,888,000 for the corresponding period last year.

Proposed work, Jan. 1 to June 1, 1926, reached a total of $2,578,157,000, compared with $2,140,157,000 for the same months in 1925.

Compared with May, 1925, last month's lettings gained 21 per cent in buildings and 22 per cent in construction other than buildings. Proposed work for the same periods showed gains in total buildings and construction other than buildings; a drop of 4 per cent, however, occurred in the commercial and public building group.

The construction volume curve as shown at the bottom of p. 918, has been consistently higher than the 1925 line during the past five months and is still pointing upward.

If at least one of the seven remaining months in this year does not pass the high mark set by August, 1925, then it can be said that the peak of the construction boom has been reached and passed.

It is expected, however, that the 1926 curve of construction volume will cross that of 1925 sometime between now and Dec. 31, and travel along beneath the latter for the remainder of the current year. The grand total for 1926 will probably come very close to that of the record year 1925.

Value of Contracts Let in the United States and Canada During May, 1926

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date, U. S.	Canada
Water-works	$373,000	$693,000	$221,000	$1,229,000	$476,000	$104,000	$3,096,000	$25,932,000	$138,000
Sewers	263,000	5,436,000	664,000	5,723,000	355,000	577,000	13,018,000	39,046,000	187,000
Bridges	2,788,000	160,000	827,000	1,721,000	707,000	601,000	6,804,000	27,246,000	30,000
Excavation, drainage, irrigation	.....	596,000	643,000	49,000	.....	498,000	1,786,000	10,074,000	765,000
Streets and roads	2,506,000	9,067,000	9,218,000	11,356,000	8,441,000	6,473,000	47,061,000	159,714,000	817,000
Industrial buildings	2,233,000	3,635,000	2,480,000	4,308,000	9,188,000	464,000	22,308,000	156,814,000	2,825,000
Commercial buildings	14,266,000	37,673,000	10,348,000	26,233,000	15,666,000	11,059,000	115,245,000	581,208,000	600,000
Federal Government	57,000	2,965,000	1,085,000	26,000	335,000	.....	4,468,000	20,648,000	.....
Unclassified	170,000	8,392,000	9,459,000	1,974,000	5,042,000	2,514,000	27,551,000	101,700,000	7,487,000
May, 1926	$22,656,000	$68,617,000	$34,945,000	$52,619,000	$40,210,000	$22,290,000	$241,337,000	$1,122,382,000	$12,849,000
April, 1926	27,471,000	73,176,000	24,745,000	66,349,000	48,169,000	40,136,000	280,046,000	.....	16,684,000
May, 1925	16,918,000	76,417,000	13,619,000	33,012,000	39,230,000	20,111,000	199,307,000	.....	12,082,000
Jan. 1 to date, 1926	78,939,000	375,763,000	142,138,000	243,857,000	159,018,000	122,673,000	1,122,382,000	.....	52,487,000
Jan. 1 to date, 1925	79,648,000	330,004,000	73,088,000	166,674,000	165,997,000	119,469,000	934,880,000	.....	31,959,000

Labor Rates and Conditions Throughout the Country

Building Trades Strikes in Twenty Cities

WITH the exception of a few remote and unimportant instances, demand for construction laborers is fully as heavy as it was a year ago. This is also true of workers in the manufacturing industries of the country. Building trades wages are higher and factory pay-rolls larger than at this time in 1925.

Production of basic materials continues active while the trend of wholesale prices has been consistently downward since January, 1926. The fact that reserve commodity stocks in most cases are a trifle heavier than in 1925, might be taken to mean that the purchasing power of wages is insufficient to accommodate the increasingly heavy volume of production.

The declining wholesale prices are offset to a degree by prevailing ease in money rates. This abundant credit, however, will probably not be taken advantage of for further expansion of trade and industry, until there is considerable improvement over the present volume of demand.

CONSTRUCTION LABOR

There are active strikes among building trades mechanics in about twenty cities throughout the country.

The following tabulation shows the principal localities where building trades labor troubles have been encountered since May 1, 1926:

Locality	Craft	Present Wage Per Hr.	Rate Demanded Per Hr.
Chicago, Ill.	Plasterers	$1.50	$1.75
Kansas City, Mo.	Carpenters	1.12½	1.25
	Tile marble setters' helpers	.82½	1.00
	Hoisting engineers	1.12½	1.25
Holyoke, Mass.	Mason tenders	.87½	1.00
Indianapolis, Ind.	Bricklayers	1.50	1.62½
Lockport, N.Y.	Plumbers	1.00	1.25
Providence, R. I.	Bricklayers	....	1.50
Batavia, N. Y.	Plumbers	1.00	1.12½
Toledo, Ohio	Plasterers	1.50	1.75
Paterson, N. J.	Plumbers	1.25	1.50
	Steamfitters	1.25	1.50
	Gasfitters	1.25	1.50
Cleveland, Ohio.	Painters	1.25	1.37½
	Glaziers	1.25	1.37½
St. Louis, Mo.	Asbestos workers	1.25	1.42½
Philadelphia, Pa.	Painters	1.00	1.25
Hartford, Conn.	Building laborers	.90	1.00
Rochester, N. Y.	Building laborers	.70	.75

In Kansas City, Mo. marble masons and foremen, tile setters, plumbers, steam fitters and electricians are negotiating for wage adjustment. Concurrent with the mason tenders strike at Holyoke, Mass., the shop carpenters, bricklayers, masons and plasterers moved to obtain wage advances. At Indianapolis, Ind., sheet-metal workers, painters, and decorators and hoisting engineers are on strike for higher rates. Providence, R. I., painters demand a wage increase. In Paterson, N. J., trouble was also experienced with sheet-metal workers. Carpenters at Aberdeen and Hoquiam, Wash., are moving for a wage rate of $1.12½ per hr.; the labor situation in Seattle and the Puget Sound cities, however, is favorable to continued construction activity.

Cities in which settlements with the various crafts were recently effected, are listed as follows:

Locality	Craft	Present Wage Per Hr.	Old Scale Per Hr.
Chicago, Ill.	Carpenters	$1.50	$1.37½
	Bricklayers	1.50	1.50
Dallas, Tex.	Plasterers	1.62½	1.62½
Bridgeport, Conn.	Hod carriers	.75	.65
White Plains, N.Y.	Hod carriers	1.12½*	1.00
Niagara Falls, N. Y.	Carpenters	1.15	1.10
Plainfield, N.J.	Electricians	1.37½	1.25
	Helpers	.40@.60	.50@.70
Newark, N.J.	Hod carriers	1.12½	1.00
	Building laborers	1.12½	1.00
	Bricklayers	1.75†	1.62½
	Masons	1.75†	1.62½
Cleveland, Ohio	Building laborers	.87½	.87½
St. Louis, Mo.	Painters	1.35	1.30
Davenport, Ia.	Cement finishers	1.12½	1.12½

*Effective July 1, 1926. †Effective June, 1, 1926.

A jurisdictional dispute broke out between bricklayers and plasterers in Syracuse, N. Y., resulting in a strike of the latter craft. The State Board of Conciliation and Arbitration is investigating the bricklayers strike in Boston.

The walkout of San Francisco carpenters in support of closed-shop principle has resulted in considerable

Current Building Trades Wage Rates Per Hour

(Higher rates indicated by +, decreases by —)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.12½	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.62½@1.75	1.00@1.10	1.00@1.12½	1.00	$0.65	1.12½	.40
Birmingham	1.00@1.50	.35@.87½	.75@1.00	.50@.75	.....	.75@1.75	.20@.40
Boston	1.40	1.25	1.25	.79	1.15	1.25	.50@.74
Cincinnati	1.50	1.31¼	1.31¼	.95	1.31¼	1.31¼	.45@.58
Chicago	1.50	1.37½	1.37½	.87½	1.37½	1.37½	.82½@.87½
Cleveland	1.50	1.25	1.30	.87½@1.10	+1.10	1.50	.87½
Dallas	1.62½	1.12½	1.00	.40@.75	.87½	1.00	.30@.50
Denver	1.62½	1.12½	1.12½@1.18¾	.81¼@.87½	1.00	1.15⅝	+.40@.45
Detroit	1.50	.70@1.00	.85@1.00	.90	.85@1.00	1.12½	.50@.60
Kansas City	1.50	1.12½	1.12½@1.25	.90	1.12½	1.12½	.40@.75
Los Angeles	1.37½	1.00	1.00	.87½	.80	1.00	.50
Minneapolis	+1.25	+.87½@95	.87½	+.75	....	+1.00	+.45@.60
Montreal	1.00	.80	+.60	+.35@.40	.50	.80	+.30@.35
New Orleans	1.25	.90	1.00	.75	.85	1.25	.35@.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.50	.90⅝
Philadelphia	1.50@1.62½	1.12½@1.25	1.02¼	1.12½	1.00	1.12½@1.25	.45@.50
Pittsburgh	1.62½	1.50	1.37½@1.50	1.12½	....	1.50	.80
St. Louis	1.75	1.50	1.50@1.65	1.15@1.25	—1.25	1.50	.45@.75
San Francisco	1.25	1.00	1.00	.81¼	1.00	1.12½	.50@.55
Seattle	1.37½	1.12½	1.00@1.12½	1.00	1.00@1.12½	1.12½	.50@.62½

violence and depression of construction in the Bay district; similar trouble with this trade was experience in Los Angeles, May 15.

Among the most important adjustments of the past month were settlements effected in Cleveland and St. Louis. In the former city hod carriers, pick and shovel men, semi-skilled and concrete workers, called off an eleven week strike and returned to work at the old rate of 87½c. per hr., which rate will remain in effect until May 1, 1927. In St. Louis the union painters are signed up for $1.35 per hr., an advance of 5c. over the old rate, to remain effective until Sept. 1, 1926, at which time the schedule will be advanced 2½c. per hr. For one year beginning May 1, 1927, the wage for this trade will be $1.43¾ per hr. Davenport, Ia. cement finishers are signed up at the old wage of $1.12½ per hr., to remain in force until May, 1927.

The Minnesota Building Employers Association, representing open shop contractors in Minneapolis, St. Paul and Duluth, have granted several wage increases, as follows: Bricklayers and plasterers minimum, $1.25 as against $1.12½ formerly; carpenter "finishers," 95c., the general carpenters rate to remain at 87½c.; common laborers acquiring some degree of skill, 60c., compared with the previous maximum rate of 55c. per hr. Plasterers' tenders, who are replacing hod carriers in large construction projects, will get 75c., against the old rate of 71½c. per hr. The new schedule is largely by way of adjustment to approach scales obtaining in other large cities of the Middle West, which in many instances are considerably higher than the one shown for Minneapolis.

Twenty-six out of fifty-five skilled trades in New York City receive $12 per day. Five crafts, namely, bricklayers, hoisting engineers, plasterers, stonemasons, and stone setters, receive $14 per day. Structural iron workers or housesmiths, will receive the $14 rate after July 1, 1926. Conditions are tranquil among the building trades in this city at the present time. The question remains as to whether or not the mechanics getting the $12 rate and under will, at some future time, push demands for the $14 now enjoyed by the five crafts just mentioned.

Monthly Prices of Construction Materials

Ups and Downs of the Market

Pig Iron—Prices appear to be settling at present levels with buying inactive; the average is about 3 per cent above that of a year ago.

Railway Supplies—Light rails moved up $2 per ton during the past two weeks, making current quotations about $1 per ton above June, 1925. White and red oak and sap pine-cypress ties advanced 5 to 8c. in St. Louis during the month.

Pipe—Demand for welded steel pipe is fairly active in the current market with prices steady. Cast-iron pipe is about $1 per ton above a year ago. No less than 50,000 tons of foreign c.i. pipe were used in the U. S. during 1925, which was, roughly estimated, one-fifteenth of the total requirements of the nation. With the exception of slight declines in Boston and Philadelphia on seven pipe, sizes above 5-in., prices remained firm in eighteen other cities reporting.

Road and Paving Materials—Among twenty-one cities reporting, the only price fluctuations in this group, during the month, were as follows: Drop of 0.1c. per gal. in road oil and 10c. per lin.ft. in curbing at St. Louis; rise of $2 per ton in bulk asphalt and decline of 50c. per sq.yd. in 4-in. wood blocks at Kansas City, Mo.; reduction of 5c. per sq.yd. on 3½-in. wood blocks in Boston.

Sand, Gravel and Crushed Stone—The first two are extremely steady throughout the entire country. Crushed stone is up 10c. in the San Francisco district; prices are exactly the same as a year ago on ¾-in. stone in thirteen out of twenty cities reporting regularly to *Engineering News-Record.*

Lime and Cement—St. Louis, Boston and Dallas lime prices are down; the other cities remain unaffected. Cement took a slight drop in Boston and Atlanta during May; firmness prevailed in forty-three other localities reporting.

Brick and Hollow Tile—With the former holding a strong position as to price, it is evident that the influx of foreign made brick has not flooded the market up to the present time. Strikes occurred in both brick yards and tile plants in the New York district, during the past month. Tile quotations show three declines to two advances, comparing present prices with those in effect at this time last month.

Structural Steel—The minimum on shapes, plates and bars is about 10c. per 100 lb. below that of a month ago at mills. A strong upward tendency in reinforcing bars developed during the past week, however, which may result in a general rise of about $2 per ton.

Lumber—Declines are in excess of advances, comparing prices in twenty-one cities with those in effect last month. The slowness is mainly in dimension lumber, timbers, siding, and finish. Demand shows improvement, however, in railway material, common boards and lath.

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	June. 3	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	$24.05	$23.05
Northern Basic	24.27	22.27
Southern Ohio No. 2 (silicon 1.75@2.25)	24.27	22.27
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	28.37	27.37
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	22.00	20@22
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	*23.26*	23.26
Virginia No. 2 (silicon 2.25@2.75)	*28.67*	29.17
Basic	*22.26*	22.26
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	*22.50*	22.00
No. 2 Foundry Southern (silicon 2.25@2.75)	*27.05*	25.55
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	21.27	22.77
Basic	21.27	22.77
Bessemer	21.27	22.77

SCRAP—The prices following are f.o.b. per net ton paid by dealers:

	New York*	Chicago	Birmingham
No. 1 railroad wrought	*$13.75*	*$11.00@$11.50*	$12.00@$13.00
Stove plate	10.25	*13.50@ 14.00*	14.00@ 14.50
No. 1 machinery cast		*16.00@ 16.25*	17.00@ 17.50
Machine shop turnings	*9.25*	*6.00@ 6.50*	8.00@ 8.50
Cast borings	11.25	*8.75@ 9.25*	8.00@ 9.00
Railroad malleable	*16.25*	*14.50@ 15.00*	16.00@ 17.00
Re-rolling rails	*12.25*	*13.25@ 13.75*	15.00@ 16.00
Re-laying rails	23.50		21.00@ 22.00
Heavy melting steel	11.75	*10.65@ 11.15*	13.00@ 14.00

*Gross ton.

Railway Supplies

STEEL RAILS—The following quotations are per ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	June 3	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	.....
Standard openhearth rails	43.00	43.00	43.00	43.00	$51.00
Light rails, 8 to 10 lb.	34@36	33@35	34@36	1.80@1.90	2.05*
Light rails, 12 to 14 lb.	34@36	33@35	34@36	1.80@1.90	1.88*
Light rails, 25 to 45 lb.	34@36	33@35	34@36	1.80@1.90	1.84*
Re-rolled rails	30@33	30@32	.....	34@36	17.50@18.00

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, white oak, plain	$1.35	$1.65
Chicago, empty cell creosoted	1.70	2.00
Chicago, zinc treated	1.50	1.80
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	**1.23**	**1.50**
St. Louis, zinc treated	**1.63**	**1.90**
St. Louis, red oak, plain	**1.13**	**1.40**
St. Louis, sap pine-cypress	**.95**	**1.25**
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh			St. Louis	San Francisco	Birmingham
	June 3	One Year Ago	Chicago			
Standard spikes, ⅝-in. and larger	$2.80	$2.80	$3.55	$3.65	$4.35	$3.00
Track bolts	3.90@4.15	3.90@4.00	4.55	4.40	5.85	3.90
Standard section angle bars	2.75@2.80	2.80	3.40	3.25@3.75	4.00	4.15

Pipe

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	12

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

STEEL PIPE—From warehouses at the places named the following discounts hold for welded steel pipe:

	Black			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	53%	58%	62%	49%
2½ to 6 in. lap welded	48%	55%	59%	46%

	Galvanized			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	39%	45%	50½%	36%
2½ to 6 in. lap welded	35%	42%	47½%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36—5% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham	Burlington, N. J.	New York June 3	New York One Year Ago
4 in.	$45.00@46.00	$53.00@55.00	$55.60@57.60	$54.60@55.60
6 in. and over	41.00@42.00	49.00@51.00	51.60@53.60	50.60@51.60

	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	$53.20	$53.20@54.20	$51.50	$56.00
6 in. and over	49.20	49.20@50.20	47.50	52.00

Gas pipe and Class "A," $4 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

Size, In.	New York June 3	New York One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$48.00	$40.00	$45.00	.....	$73.00
4	55.00	50.00	40.00	56.00	$76.50	110.00
5	.....	.....	.....	80.00	97.75	118.00
6	90.00	92.00	70.00	100.00	127.50	150.00
8	160.00	160.00	170.00	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	....	$0.10	$0.10	.....	$0.09	$0.12	.....
4	....	.10	.10	$0.10	.09	.15	$0.15
5	....	.1375	.135	.....	.13½	.18	.18
6	$0.21	.1375	.135	.14	.13½	.21	.21
8	.35	.225	.21	.225	.21	.30	.325
10	.52	.2625	.315	.315	.31½	.42	.476
12	.66	.3375	.45	.405†	.40½	.56	.612
15	1.14†	.45	.54	.675†	.54	.92	1.02
18	1.65†	.625	.75	.945†	.75	1.32	1.53
20	1.98†	.75	.90	1.26†	.90	.....	.....
22	2.65†	1.00	1.20	.....	1.20	.....	1.564
24	2.97†	1.125	1.35	1.62†	1.35	2.16	2.04
27	4.65†	2.405	2.665	2.45†	2.75	3.00	3.34
30	5.16†	2.664	2.952	3.00†	3.75	3.60	4.06
33	6.98†	3.60	3.96	3.55†	4.50	....	4.99
36	8.00†	4.10	4.51	3.95†	5.00	.....	5.42

	3	5	8	12	24	36
Boston	$0.13	$0.20	*$0.28*	*$0.58*	$2.00†	$5.50†
Minneapolis	.....	.....	.25	.45	1.50	4.56
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.14	.....	.35	.72†	2.60†	.....
Los Angeles	.1625	.195	.275	.495	1.65	.....
New Orleans	.116*	.277*	.295	.463	1.785	.....
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.25	.425	1.625	.....
Montreal	.68‡	.45†	.70	1.35	4.50†	.....
Detroit	.105	.1575	.245	.4725	2.16†	5.6375†
Baltimore	.111	.166	.259	.499	1.665	4.92
Kansas City, Mo.	.15*	.21*	.29	.52	1.90†	3.80†
Philadelphia	.11	*.16*	.26	*.42*	*1.50*	*3.70*

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars, 8,000 gal. minimum f.o.b. place named:

		June 3	One Year Ago
New York, 45% asphalt	(at terminal)	†0 065 @$0.07	$0.065 @0.07
New York, 65% asphalt	(at terminal)	0675@ .0725	.0675@.0725
New York, binder	(at terminal)	.07 @ .075	.07 @.075
New York, flux	(at terminal)	.07 @ .075	.07 @.075
New York, liquid asphalt	(at terminal)	.07 @ .075	.07 @.075
St. Louis, 40@50% asphalt		.055	.049
St. Louis, 50@60% asphalt		*.0565*	.0527
Birmingham, 55% asphalt		.0475	0475
Dallas, 45% asphalt		.0495	.0495
Dallas, 55% asphalt		.0455	.0455
Dallas, binder		.061	.061
San Francisco, binder, per ton		12.00*	13.50*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$23.00	$18.50
Boston (*Mexican*)	23.00	18.50
Chicago (*Texas*)	27.00	23.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, *"D" grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	.....
Minneapolis, *f.o.b. Twin Cities (Standard)*	27.60	21.60
St. Louis (*Mexican*)	26.00	23.00
Baltimore (*Mexican*) (*f.o.b. refinery*)	22.50	18.00
Montreal (*Imperial*)	28.00	21.00
Atlanta (*Mexican*)	24.60	20.40
Detroit (*Mexican*)	22.25	18.50
Cincinnati (*Kentucky Rock*)	.....	11.65
Maurer, N. J. (*Bermudez*)	30.00	.....
Maurer, N. J. (*Trinidad*)	23.00	.....
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, Mo. (*Texas*)	27.30	**24.30**
Los Angeles ("*D*" *grade, California*)	*18.00	*12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

* F.o.b. El Segundo Refinery. Drums used in New York.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade I)	5-in. granite, 30 blocks per sq.yd		$147.00 per M.
San Francisco	Basalt block 4x7x8		70.00 per M.
Chicago		about 5x8x5 dressed	3.60 per sq.yd
		about 5x8x5 common	3.25 per sq.yd.
Boston	5-in. Granite		135.00 per M.
Atlanta	Granite		2.50 per sq.yd.
Detroit	5-in. Granite		3.00 per sq.yd.
Baltimore	Granite		2.85 per sq.yd.
Montreal	Granite		104.75 per M.
New Orleans	Granite, 4x8x4		2.75 per sq.yd.
Cincinnati	Granite		135.00 per M.
St. Louis	Granite, 4x8x4		1.65 per sq.yd.
Kansas City	Granite		3.15 per sq.yd.
Philadelphia	Granite		3.90@4.25 per sq.yd.
Minneapolis	Sandstone		2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 88c.; *St. Louis*: Class "A" straight, delivered, 5x18 in., *$0.95* per lin.ft.; roundings, *$1.50*. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

WOOD BLOCK PAVING—	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	*2.45*
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.45
St. Louis	4	16	2.75
Seattle	4	16	Off market
Minneapolis	3½	16	2.40
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Detroit	4	16	.....
Cincinnati	3½	16	2.35
Kansas City	4	16	*2.50*
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractor f.o.b., per cu.yd. is as follows:

	Gravel				Sand	
	1½ In.		¾ In.			
	June 3	One Year Ago	June 3	One Year Ago	June 3	One Year Ago
New York (*alongside dock*)	$1.75	$1.75	$1.75	$1.75	$1.00	$1.00
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	1.60	.....	1.60	.....	1.40	.....
St. Louis	1.45	1.45	1.45	1.45	1.08	1.18
Seattle	1.50	1.50	1.50	1.50	1.50	1.50
Dallas	2.38	2.38	2.38	2.38	2.00	2.00
Minneapolis	1.65*	1.65*	1.65*	1.65*	1.25	1.25
Cincinnati	1.40†	1.40†	1.40†	1.40†	1.35†	1.35†
San Francisco	1.80	2.15	1.80	2.15	1.40	1.50
Boston	1.50†	1.50†	1.50†	1.50†	1.00†	1.00†
New Orleans	3.00	2.60	3.00	2.60	1.80	1.75
Los Angeles	1.15†	1.30†	1.15†	1.30†	.90*†	1.10†
Atlanta	1.90†	1.90†	1.90†	1.90†	1.50†	1.40†
Detroit	1.45†	2.02	1.35†	2.02	*1.10*†	1.62
Baltimore	1.40	1.40	1.60	1.60	.70*†	.70*†
Montreal	1.25†	1.25†	**1.50**†	1.25†	1.25†	1.25†
Birmingham	2.00	2.00	2.00	2.00	1.50	1.45†
Philadelphia	2.10	2.10	2.10	2.10	1.50	1.50
Kansas City	4.00‡	4.00‡	4.00‡	4.00‡	.66*†	.66*†

New York—Grits, $1.75 per cu.yd.; ready mixed $1.85.
Los Angeles—Freight from quarry, 70c. per ton, and is included in above price.
* At pit. † Per ton. ‡ Joplin chats.

CRUSHED STONE—Price for cargo or carload lots, per cu.yd. f.o.b. city, is as follows:

	1½ In.		¾ In.	
	June 3	One Year Ago	June 3	One Year Ago
New York	$1.75	$1.75	$1.85	$1.85‡
Chicago	1.75	.....	1.87½‡	.....
St. Louis	1.83*	1.83*	1.93*	1.93*
Dallas	2.40	2.40	2.83	2.83
San Francisco	**1.80**	2.15	**1.80**	2.15
Boston	1.60*	1.60*	1.60*	1.60*
Minneapolis	1.75	1.75	1.75	1.75
Kansas City	2.00	1.50	2.00	1.50
Denver	2.50	2.50	2.50	2.50
Seattle	3.00	3.00	3.00	3.00
Atlanta	2.50*	2.00*	2.50*	2.00*
Cincinnati	1.90*	1.90*	1.90*	1.90*
Los Angeles	1.40*	1.50*	1.40*	1.50*
Detroit	2.00*	1.50	2.00*	1.50
Baltimore	2.50	2.50	2.55	2.55
Montreal	1.80*	1.80*	**1.70***	1.90*
Philadelphia	2.10	2.10	2.10	2.10
Pittsburgh	2.85	2.85	2.85	2.85
Cleveland	3.25*	3.25*	3.25*	3.25*
Birmingham	2.00	2.00	2.00	2.00

* Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant

	1½-In	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Steubenville District	1.25	1.30	2.00	1.30
Ironton District	1.40	1.40	2.00	1.40
Birmingham, Ala	.80@.90	1.15	2.05	.....
Cleveland, Ohio	1.80	1.80	....	1.75
Eastern Pa. and Northern N. J.	1.25	1.25	2.50	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25

CONCRETE MASONRY UNITS—Standard 8x8x16-in., delivered to job in Milwaukee district, $0.21 each.

LIME—Warehouse prices:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	$18.20	$12.00@$13.10	$3.50*	$2.25@2.75*
Chicago	20.00	18.00	.....	2.25*
St. Louis	*23.50*	*19.50*	*2.03*†	15.00‡
Boston	*19.50*	*12.50@13.50*	*3.70**	*2.95**
Dallas	*18.00*	.....	.....	*1.85*†
Cincinnati	16.80	14.30	.....	13.40‡
San Francisco	22.00	22.00	.....	1.60†
Minneapolis	25.50	21.00	....	1.60@1.70†
Denver	24.00	.....	....	2.70*
Detroit	18.50	15.00	....	18.50‡
Seattle, *paper sacks*	24.00	.....	2.80†	.....
Los Angeles	25.00	18.00	3.50*	19.50‡
Baltimore	24.25	17.85	2.55†	.....
Montreal	.....	21.00	.....	10.00‡
Atlanta	23.50	13.00	2.20†	1.50†
New Orleans	24.00	*15.00*	2.50†	2.00*
Philadelphia	23.00	16.00	....	.....
Kansas City	17.50	15.00	2.59†	2.24*
Birmingham	22.50	16.00	2.40†	1.85†

* Per 280-lb. bbl. (net). † Per 180-lb. (net). ‡ Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	May 6	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	**1.50**	1.35
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	2.60	2.50
St. Louis (Carney)	**2.85**	2.35
Birmingham (Magnolia) pozzolan cement	2.40	2.40

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	June 3	One Month Ago	One Year Ago
New York, del. by truck	$2.50@$2.60	$2.50	$2.50@$2.60
New York, alongside dock to dealers	2.15	2.15	2.15
Jersey City	2.33	2.33	2.33
Boston	*2.35*	2.40	2.55
Chicago	2.10	2.10	2.20
Pittsburgh	2.09	2.09	2.19
Cleveland	2.29	2.29	2.39
Detroit	2.15	2.15	2.35
Indianapolis	2.29	2.29	2.41
Milwaukee	2.25	2.25	2.35
Duluth	2.09	2.09	2.19
Peoria	2.27	2.27	2.37
Cedar Rapids	2.34	2.34	2.44
Davenport	2.29	2.29	2.39
St. Louis	2.20	2.20	2.30
San Francisco	2.31	2.31	2.31
New Orleans	2.30	2.40	2.40
Minneapolis	2.32	2.32	2.42
Denver	2.85	2.84	2.84
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	*2.25*	2.35	2.30
Cincinnati	2.37	2.37	2.47
Los Angeles	2.36	2.52	2.80
Baltimore	2.35	2.35	2.50
Birmingham	2.40	2.40	2.40
Kansas City, Mo	2.35	2.35	2.28
Montreal	1.42	1.80	1.80
Philadelphia	2.41	2.41	2.41
St. Paul	2.32	2.32	2.42
Toledo	2.20	2.20	2.40

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind	$1.85	Hudson, N. Y	$2.05
Universal, Pa	1.85	Leeds, Ala	1.95
Steelton, Minn	1.90	Hannibal, Mo	1.95
Fordwick, Va	2.05	Lehigh Valley District	1.95
Mitchell, Ind	1.95	Wyandotte, Mich	1.90
Iola, Kan	1.85	Alpena, Mich	1.75
Mason City, Ia	1.90	Richard City, Tenn	2.05
La Salle, Ill	1.95	Kingsport, Tenn	2.05

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.97	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.23	1.29	1.76	1.35	1.38	1.55
068	35	1.51	1.58	2.16	1.66	1.67	1.91
093	45	1.94	2.03	2.77	2.13	2.00	2.46
126	57	2.39	2.51	3.45	2.63	2.55	3.03
153	68	2.86	2.99	4.11	3.14	3.15	.....
180	78	3.28	3.43	5.70	3.60	3.47	.....
245	103	4.33	4.53	6.21	4.75	4.58	.....
287	119	5.00	5.24	7.19	5.50	5.26	6.35
336	138	5.80	6.07	8.35	6.37	6.11	.....
395	160	6.72	7.04	9.65	7.38	7.12	.....
		PAVING					
036P	17	$0.74	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.04	1.09	1.50	1.14	1.07	.....
072P	31	1.32	1.38	1.90	1.45	1.39	.....
097P	40	1.70	1.78	2.45	1.87	1.90	.....
049R	24	1.04	1.09	....	1.14	1.07	.....
067R	31	1.32	1.38	....	1.45	1.39	.....
089R	40	1.70	1.78	....	1.87	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted:

Weight in pounds	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$17.00	$19.50	$17.50	$17.00	$19.00	$19.00
2.5	18.50	21.50	19.00	18.50	21.00	21.00
3.0	21.50	24.50	22.00	21.50	23.00	24.50
3.4	23.50	27.00	24.00	23.50	25.50	27.00

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$1.90	$2.25	$3.24	$3.00	$3.15	$3.38	$3.10
⅝	2.00	2.35	3.34	3.10	3.25	3.43	3.20
¾	2.10	2.45	3.44	3.20	3.35	3.48	3.30
⅞	2.30	2.65	3.64	3.40	3.55	3.63	3.50
1	2.90	3.25	4.24	4.00	4.15	3.78	4.10

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

ROLLED FROM RAILS

	St. Louis	Dallas		St. Louis	Dallas
½ and larger	$2.35	$2.80	⅝	$2.75	$3.02
¾ in.	2.45	2.85	1	3.35	3.20
1¼	2.55	2.90		....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: June 3	One Month Ago	One Year Ago	Paving Block: 3-inch*	3½-inch*
New York (del.)	$20.40	$20.40	$18@19	$45.00	$51.00
New York (at dock)	17.00	17.00	15@16	.....	.....
Chicago	12.00	12.00	12.00	42.00	45.00
St. Louis, salmon (del.)	16.00	16.00	16.00	40.00	42.50
Denver, salmon	12.00	11@13	12.00	.....	.....
Dallas	14.10	12.00	12.10	35.00	.....
San Francisco	15.00	15.00	15.00	.....	.....
Los Angeles	11.50	11.50	13.00	(not used)	
Boston (del.)	18.50	18.00	17.50	45.00	50.00
Minneapolis (del.)	14.25	14.25	13.50@13.60	.....	.....
Kansas City	15.00	15.00	14.50	(no market)	
Seattle	15.00	15.00	15.00	.....	42.50
Cincinnati	17.00	17.00	17.00	40.00	45.00
Montreal	17.50	20.25	17.50	100.00†	68.00
Detroit (del.)	16.00	16.00	17.50	38.40	41.50
Baltimore	18.00	18.00	18.00	40.00	45.00
Atlanta	10.50	10.50	10.50	40.00	.....
New Orleans	15.00	15.00	15.00	.....	50.00
Birmingham	12.50	12.50	12.50	40.00	45.00
Philadelphia	18@19	17@20	19.00	40.00	50.00
Pittsburgh (del.)	16.00	16.00	16.00	.....	.....
Cleveland	14.00	14.00	14.00	.....	.....

*For paving blocks 3x8½x4 and 3½x8½x4 respectively. †Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: June 3 on Trucks*†	One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12	$0.1112	$0.1162	$0.075	$0.12	$0.07	$0.108	.....
6x12x12	.1667	.1743	.096	.....	.094	.156	.....
8x12x12	.2084	.2179	.135	.22	.128	.244	.....
10x12x12	.....	.....	.167	.....	1.60	.....	$0.252
12x12x12	.....	.....	.215	.....	1.90	.....	.312

*5 per cent off for cash. †Partition tile.

	4x12x12	8x12x12	12x12x12
Boston	$0.085	$0.175	.....
Minneapolis (f.o.b. cars)	.068	.1175	$0.205
Minneapolis (delivered)	.076	.13	.225
Cincinnati	.07485	.13745	.....
Kansas City	.088	.158	.242
Denver	.075	.155	.188
Seattle (delivered)	.09	.18	.26
Los Angeles	.085	.172	.....
New Orleans	.13	.20	.35
Detroit (delivered)	.1095	.2821	.....
Montreal	.12	....	.....
Baltimore	.125	.27	.....
Atlanta	.0895	.1837	.....
Dallas	.112	.21	.31
Birmingham	.11	.124	.255
Pittsburgh (delivered)	.068	.128	.179
Cleveland	.07	.149	.....

STRUCTURAL MATERIAL—Following are base prices f.o.b. mill, Pittsburgh and Birmingham, together with quotations per 100 lb. from warehouses at place named:

	Pittsburgh Mill	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.80@1.90	$2.05	$3.34	$4.15	$3.25	$3.10	$3.30
Channels, 3 to 15 in.	1.80@1.90	2.10	3.34	4.15	3.25	3.10	3.30
Angles, 3 to 16 in., ¼ in. thick	1.80@1.90	2.10	3.34	4.15	3.25	3.10	3.30
Tees, 3 in. and larger	1.80@1.90	2.10	3.34	4.15	3.35	3.10	3.30
Plates, ¼ in. thick and heavier	1.80@1.90	2.00	3.34	4.15	3.25	3.10	3.30

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	Warehouse: New York—June 3	New York—One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.50@2.60	$4.50	$4.50	$3.50	$3.65	$5.00	$4.75
CONE HEAD BOILER							
½ in.	2.90	$4.70	$4.60	$3.70	$3.85	$5.20	$5.00
⅝ and ¾	3.05	4.85	4.75	3.80	4.20@4.45	5.35	5.15
⅞ and 1	3.30	5.10	5.00	4.05	4.60	5.60	5.50

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.65	$2.85	$3.05	$3.75	$4.25	$2.93	$4.95
Cut	2.80	2.90	....	5.30	5.00	3.15	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	Black	Seattle Black
½	$7.50	$5.75	$7.75
⅝	7.05	5.30	5.60
¾	6.90	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, $3.25.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls of 108 sq.ft. costs $2.35@$2.50 per roll to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $7.00 per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in l) f.o.b. New York, in carload lots to contractors, $5.00 per square.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$70.00
Asphalt roofing (in barrels) per ton	25.00
Asphalt felt, per ton	72.00

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 87 per cent; "B," 89 per cent. Double thickness "AA," 82 per cent; "A," 86 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	2.40@ 2.50	$3.60	$3.50	$3.90	$3.89
No. 12	2.45@ 2.55	3.65	3.55	3.95	3.94
No. 14	2.50@ 2.60	3.70	3.60	4.00	3.99
No. 16	2.60@ 2.70	3.80	3.70	4.10	4.09
Black					
*Nos. 18 to 20	2.95@ 3.05	4.40	3.90	4.75	4.30
*Nos. 22 to 24	3.00@ 3.10	4.45	3.95	4.80	4.35
*Nos. 26 and 27	3.05@ 3.15	4.50	4.00	4.85	4.40
*No. 28	3.15@ 3.25	4.60	4.10	4.90	4.50
Galvanized					
No. 10	3.40@3.50	4.70	4.25	5.00	4.65
Nos. 12 to 14	3.50@3.60	4.80	4.35	5.10	4.75
No. 16	3.65@3.75	....	4.50	5.25	4.90
Nos. 18 to 20	3.80@3.90	5.10	4.65	5.40	5.05
Nos. 22 to 24	3.95@4.05	5.25	4.80	5.55	5.20
*Nos. 26 and 27	4.10@4.20	5.40	4.95	5.70	5.35
*No. 28	4.40@4.50	5.70	5.25	6.00	5.65

* For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: June 3	New York: One Year Ago	Chicago: June 3	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	$0.84	$1.09	$0.85	$1.23

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price f.o.b. New York:

	Dry		In Oil	
	June 3	1 Yr. Ago	June 3	1 Yr. Ago
Red	$15.25	$15.75	$16.75	$17.25
White	15.25	15.75	15.25	15.75

Lumber

Prices wholesale, per M ft. b.m., to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00
3x10 and 12	26.00	27.00	28.00	31.00
3x14	30.00	30.00	32.00	34.00
4x10 and 12	26.00	27.00	28.00	31.00
4x14	30.00	30.00	32.00	34.00
	24 Ft. and Under		25 to 32 Ft.	33 to 40 Ft.
6x10	$28.00		$30.00	$32.00
6x14	34.00		36.00	38.00
8x10	28.00		30.00	32.00
8x14	34.00		36.00	38.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York		Chicago	
	20 Ft. and Under L.L.Y.P.	22-24 Ft. L.L.Y.P.	20 Ft. and Under No. 1 L.L.Y.P.	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$43.00	$44.00	$42.50	$41.00
3x10 to 10x10	50.00	51.00	47.50	41.00
3x12 to 12x12	57.00	58.00	57.50	41.00
3x14 to 14x14	65.00	66.00	.....	41.00
3x16 to 16x16	77.00	78.00	.....	42.00

New York—Wholesale price of long-leaf pine to dealers; to contractors, delivered from lighters or cars to job, $5 to $10 additional. Short-leaf pine costs $3 per M. ft. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$51.00	$48.50†	$51.00	$50.50	*$60.00*	*$58.00†*
Seattle		24.00	.....	.....	.....	25.00
New Orleans	35.00	.....	.....	.....	43.00	.....
Baltimore	32.50	49.25	53.00	60.00	38.00	49.75
Cincinnati	37.00	43.00	73.00	85.00	48.00	77.00
Montreal	50.00	58.00	.....	.....	60.00	65.00
Los Angeles	.....	36.64	.....	.....	.....	36.64
Denver	.....	34.75	34.75	34.75	.....	34.75
Minneapolis	42.00	39.00	35.00	.....	44.00	39.75
Atlanta	31.00	.....	.....	.....	34.00	.....
Dallas	56.00	.....	.....	.....	56.00	.....
Kansas City, Mo.	44.50	40.75	.....	.....	59.50	41.75
Birmingham	32.00	.....	.....	.....	34.00	.....
Philadelphia	54.00	36.00	38.00	45.00	65.00	36.00
Detroit	47.75	46.75	.....	.....	61.75	46.75
St. Louis	*41.00*	.....	.....	.....	*53.00*	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$46.00	$42.50†	$45.00	$50.00	$48.00†
Seattle	.....	20.00	.....	.....	24.00
New Orleans	72.50	.....	.....	45.00	.....
Baltimore	55.00	44.00	44.00	34.00	50.00
Cincinnati	70.00	79.00	75.00	38.00	85.00
Montreal	45.00	50.00	40.00	65.00	50.00
Los Angeles	.....	35.64	.....	.....	.....
Denver	.....	*32.25*	33.25	.....	33.25
Minneapolis	42.50	36.75	34.75	37.00	34.25
Atlanta	22.00	.....	.....	28.00	.....
Dallas	52.00	.....	.....	56.00	.....
Kansas City, Mo.	54.25	40.75	.....	42.25	36.75
Birmingham	27.00	.....	.....	42.00	.....
Philadelphia	32.00	35.00	36.00	52.00	35.00
Detroit	39.75	37.00	.....	46.50	41.25
St. Louis	**42.00**	.....	.....	*29.50*	.....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M. ft. to contractors.
Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.
Denver—Quotes dealers price to contractors on large projects.
St. Louis—Wholesale price to contractors, f.o.b. cars, $2 per M.ft. additional.
Seattle—Price to contractors, delivered.
Dallas—Wholesale to contractors, $10 per M.ft. additional.
*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

June 3	One Month Ago	One Year Ago
$2.25@$2.30	$2.25@$2.30	$2.25@$2.30

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.
Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.
Arizona: Discount 10 points less than discount for Eastern territory.
Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.
North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft.; ⅜-in., 6; ½-in., 4½; ⅝-in., 3½; ¾-in., 2 ft. 10 in.; 1-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	$0.20	New Orleans	$0.25½
New York	.26	Los Angeles	.25
Chicago	.24½	Seattle	.24
Minneapolis	.27½	St. Louis	.24½
San Francisco	.25	Montreal	.16
Atlanta	.30	Detroit	.24½
Denver	.26@.27	Baltimore	.18
Cincinnati	.21	Kansas City	.28
Dallas	.31	Birmingham	.26@.27
Philadelphia	.26		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.2875*
Boston	.23	.255
Kansas City	*.2025*	*.22*
Seattle	.165	.19
Chicago	.215*	.2375*
Minneapolis	.1917	.2123
St. Louis	*.22*	*.245*
Denver	.2025	.2275
Dallas	.225	.302
Los Angeles	.1875	.2225
Atlanta	.215	.24
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.195	.235
Birmingham	.22	.24
New Orleans	.233	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

*Special gelatin.

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f.o.b. works:

Sulphate of aluminum, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	4.75@5.00
Soda ash, 58%, in bags, per 100 lb	1.38@1.55
Chlorine, liquid, tanks, per lb	.04@.04½
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	2.00@2.10

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.